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RECORDS  
OF THE  
WESTERN AUSTRALIAN  
MUSEUM AND ART GALLERY

EDITED BY THE DIRECTOR,  
BERNARD H. WOODWARD, F.G.S., C.M.Z.S.

VOLUME I.  
PART I.

CONTENTS.

	PAGE
INTRODUCTION, by the Editor	7
THE MAMMOTH CAVE, by L. Glauert, F.G.S.	11
TACHYGLOSSUS ACULEATUS	13
PHASCOLOMYS HACKETTI	15
PHASCOLARCTUS CINEREUS	29
STHENURUS OCCIDENTALIS	31
MUSEUM NOTES	37

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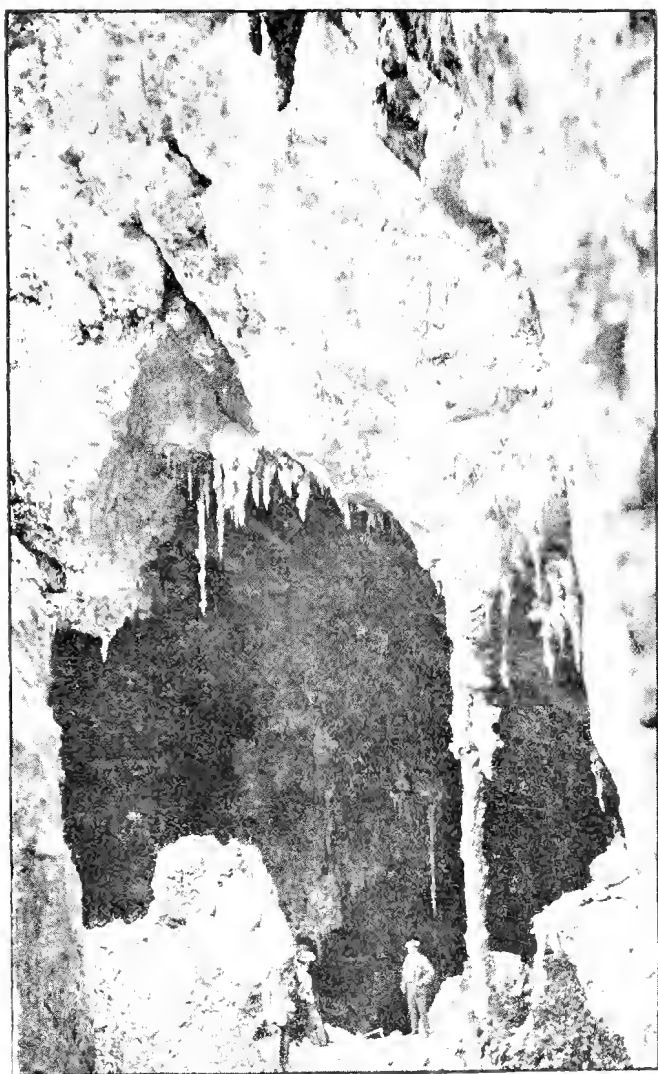
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ENTRANCE TO THE MAMMOTH CAVE.

This illustration has been kindly lent by EDGAR ROBINSON, Esq.,  
the Superintendent of the Caves.

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# THE WESTERN AUSTRALIAN MUSEUM AND ART GALLERY.

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## RISE AND PROGRESS.

**1889.**—**The Geological Museum**, Perth, established to display the specimens collected by Mr. H. Page Woodward, F.G.S., and by his predecessors in the office of Government Geologist, and to receive the contents of the Fremantle Geological Museum, which had been founded in 1881, by the Rev. C. G. Nicolay.

**1892.** The scope of the Institution was widened to include general Natural History and Ethnology. The contents of the Museum of the Swan River Mechanics' Institute purchased. That Institution was founded by Capt. John Septimus Roe, R.N., in 1860. The title abbreviated to the **Perth Museum** and the connection with the Geological Department terminated.

**1895.** The Mineral Gallery built; the collections placed under the control of a Committee; the Art Collections commenced.

**1897.** The James Street frontage erected. The present title given to denote that the Institution was National, not merely local.

**1899.** The Bird Gallery opened.

**1906.** The Mammalian Gallery installed.

**1908.** The Beaufort Street wing opened as an Art Gallery on the 25th June by H.E. the Governor, Sir F. G. D. Bedford, G.C.B.

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## FREE POPULAR LECTURES ON SCIENCE AND ART.

These Lectures, commenced in 1905, are delivered on alternate Friday evenings during the winter months and have proved most successful. The sixth series opens on April 8th next with a Lecture on "Some forward impulses in the History of Agricultural Progress," by Prof. W. Lowrie, to be followed by Lectures on Art and Science by the leading authorities in the State on such subjects. A programme will shortly be published.

# RECORDS

OF THE

## WESTERN AUSTRALIAN MUSEUM AND ART GALLERY.

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THE time has arrived when it has become necessary to issue Records, as is done by the older Museums.

These will deal almost entirely with the Natural History of this State. They will contain the results of Original Research, of Collecting Expeditions, and will also include brief notes on other matters connected with this Institution.

Hitherto this information has been published through the medium of various Australian, British and foreign publications.

BERNARD H. WOODWARD,

*Director.*

*1st January, 1910.*



# FOSSIL MARSUPIALS OF WESTERN AUSTRALIA.

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BY BERNARD H. WOODWARD, F.G.S., C.M.Z.S., DIRECTOR OF THE  
W.A. MUSEUM AND ART GALLERY.

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## INTRODUCTION.

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IN 1882, the late Mr. E. T. Hardman, F.G.S., the Government Geologist, reported the occurrence of *Diprotodon* bones in the Lennard River, Kimberley.

In 1895 Mr. Arthur found in a gully near Lake Darlot, a portion of a lower jaw of this animal, which he presented to this Museum. The specimen was, unfortunately, so much weathered that it was valueless except as a record. In 1898 the Museum Committee sent an expedition to Lake Darlot, and in 1908 the Hon. Dr. Hackett, at his own cost, sent another party to this place to search for further specimens, but neither succeeded in the quest.

In February, 1909, Mr. John Sharp, of Balladonia, Point Malcolm, on the South Coast, sent to the Museum a number of bones and a few teeth of *Diprotodon australis* that he had unearthed when sinking for water near his station, and has promised to send any more that may be found. These bones were so common in that district some years ago, that the settlers considered them of too little value to be worth preserving, but now that they have been awakened to their scientific interest, they will save and forward to Perth all future discoveries.

In 1904, Mr. E. A. Le Soeuf heard that some bones had been found in the Mammoth Cave, Margaret River, so he proceeded to the spot and secured a large number of fragments from a cutting that had been made when a pathway was being formed under the direction of the Superintendent of the Caves, Mr. Edgar Robinson.

Amongst these bones Mr. Le Soeuf found portions of two jaw bones of *Sthenurus*, which he retained, hoping to determine the species. The other specimens he returned to the Caves Board who presented them to the Museum. Unfortunately they contained nothing of interest except the posterior half of the right jaw of *Sthenurus*, which, though of no value in itself as it only carried two molar teeth, yet proved to be of the greatest interest, for when the Caves Board were enabled in 1908 to donate the jaws above-mentioned it was found to complete one of them. (See Plate V.).

In August, 1905, the writer was invited by the Hon. Dr. Hackett, who is Chairman of the Caves Board as well as of the Museum, to meet him at the Margaret River Caves to select sites for further exploration. After a careful examination he recommended that in the first place it would be advisable to thoroughly examine and excavate under the mass of stalagmite that had been partially removed in making the pathway in the Mammoth Cave. Nothing further, however, was done until February and March, 1909, when the Committee was able to obtain the services of Mr. Ludwig Glauert, F.G.S., Medallist in Geology and Demonstrator in Geology for five years in the University of Sheffield, who was then on the temporary staff of the Mines Department as palæontologist to the Geological Survey. The Hon. the Minister for Mines gave him leave of absence, without pay, in order that he might undertake this exploration under the direction of the writer. The Caves Board gave permission and the Superintendent, Mr. Edgar Robinson, rendered all assistance possible, and Mr. Glauert in less than two months collected 2,000 bones or fragments of bones. These include remains of *Diprotodon australis*, *Nototherium*, new species of *Sthenurus* and *Phascolumys*, of *Phascolarctus cinereus*, of *Echidna aculeata* and several species of wallabies; descriptions of the latter follow in Part II. of these Records. The wallabies include some species still living, *e.g.*, *M. brachyurus*; others may be new and in any case will certainly throw considerable light on the conditions which prevailed in prehistoric times on this Continent, as well as upon the relationships of the Marsupials.

The Caves Board has generously presented all these fossils to the Committee of the W.A. Museum.

The first instalment of Mr. Glauert's report, printed below, will give these Records a special interest to zoologists and palæontologists.

## THE MAMMOTH CAVE.

By LUDWIG GLAUERT, F.G.S., ETC.

The Mammoth Cave, in which were obtained the various animal remains about to be described, is one of the finest of the numerous limestone caverns to be found in the extreme south-west of this State, from Cape Naturaliste to Cape Leeuwin.

They occur in a strip of Pleistocene foraminiferal limestone, the so-called "coastal limestone," resting upon the metamorphic rocks that form the range of hills running parallel to the coast-line in that district, at a distance of about four miles from the sea. At one time the gneissic slope extended uninterruptedly from the hills to the shore, but the strong south-west winds of the summer months soon gave rise to a chain of sand dunes which travelled inland and up the gentle escarpment of the hills. The material carried along by the wind consisted not only of the quartz grains which were derived from the disintegration of these rocks, but also included small shell fragments and the minute calcareous tests of foraminifera.

Rain water, by virtue of the small amount of carbonic acid which it obtains from the atmosphere, is able to dissolve this lime and carry it in solution to the lower portions of the pervious beds. Owing to evaporation, this lime is re-deposited and in due course the loose incoherent sand becomes solidified, forming either a calcareous sandstone or a sandy limestone, according to the amount of lime present in the rock.

The formation of caves, therefore, was accomplished without difficulty, and hastened by the fact that the rainfall on the western slope of the range is considerable, and drains through the limestone belt to the coast.

The numerous winter streams that rise in the hills proceed uninterruptedly till the limestone belt is reached, when they mostly disappear, either in the mouths of caves, or in "swallow-holes." The stream that flows through the Mammoth Cave is one of the former; it continues its course underground till it issues at the foot of the sea cliffs three miles to the westward. These subterranean watercourses are usually a succession of clefts and caverns,

increasing considerably in width and height when conditions are favourable. As a general rule the upper contour of the underlying granite forms the bed of the stream, but a very hard band of the limestone will answer the same purpose, though not in so satisfactory a manner. We have an example of this in the Mammoth Cave, for the blocks of limestone in the large main chamber (the size of which suggested its name) afford distinct evidence that formerly there were two caves, one above the other. In course of time the percolating water so weakened the limestone that formed the roof of one cavern and the floor of the other, that it collapsed, uniting the two into one huge chamber, the floor of which is strewn with large masses most of them hundreds of tons in weight. It was on the upper surface of one of these blocks, quite 70 ft. above the stream which flows through the cave, that the numerous specimens were collected. To an observer standing at that spot it is evident that the remains cannot have been introduced by way of the present entrance, which is about 70 ft. lower, for many of them bear unmistakable evidence of water transport. It was therefore necessary to seek another explanation for the presence of the bones at such a height above the present cave floor, and as the features observed tend to show that the double chamber evidently had existed, that solution may safely be adopted.

The material in which the bones were embedded, varied somewhat in nature; it comprised two groups, the lower and older series consisted of a reddish, fairly coarse sand, containing fragments of wood and gastropod shells in addition to the bones, with occasional bands of black loamy soil about an inch in thickness, which seem to prove the existence of floods in days gone by. Layers of stalactite often enclosing bones, wood fragments, etc., and bearing casts of eucalyptus leaves were not uncommon, one of these layers completely covered the series, thus protecting the animal remains and accounting for their fine state of preservation.

Above this there was another sandy bed which was yellowish in colour; the bones it contained were much fresher in appearance and are undoubtedly much more recent than the remains preserved in the lower series.

A layer of stalactite varying greatly in thickness covered the lot, and it was not until this layer was pierced that the presence of



fossils was made known. This discovery suggested the advisability of further investigations, which having been undertaken under the auspices of the Western Australian Museum and the Caves Board, resulted in the collection of some thousand bones and the addition of several species to the known fauna of the State.

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ORDER MONOTREMATA. Fam. I. ECHIDNIDÆ.

*Tachyglossus* (Illiger).

*Tachyglossus* (*Echidna*) *aculeatus* (Shaw sp.) var. *typicus* (Tho).

<i>Myrmecophaga aculeata</i> , Shaw .. ..	Nat. Misc. iii., pl. cix, 1792
<i>Ornithorhynchus hystrix</i> , Home .. ..	Phil. Trans. 1802, p. 348, pls. 10-12
<i>Echidna hystrix</i> , E. Geoff. .. ..	Cat. Mus. p. 224, 1803
„ <i>longiaculeata</i> , Tiedm. .. ..	Zool. i., p. 592, 1808
<i>Tachyglossus aculeatus</i> , Ill. .. ..	Prodr. Syst. Mamm. p. 114, 1811
<i>Echinopus hystrix</i> , G. Fisch. .. ..	Zoogn. iii., p. 692, 1814
<i>Echidna aculeata</i> , Garnot .. ..	N. Bull. Soc. Philom., p. 45, 1825
„ <i>australiensis</i> , Lesson .. ..	Man. Mamm., p. 318, 1827
<i>Tachyglossus hystrix</i> , Kaup. .. ..	Thierr. i., p. 255, 1835
<i>Echidna australis</i> , Lesson .. ..	Compl. a Buffon V., pl. 52, 1836
„ <i>acanthion</i> , Collett .. ..	Forb. Vid. Selsk., 1884, No. 13, 1885
„ <i>aculeata</i> var. <i>typica</i> , Thomas .. ..	P.Z.S. 1885, p. 338, pl. 23, 1886
„ „ „ „ .. ..	Cat. Marsup. Brit. Mus., p. 379.

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## THE NATIVE PORCUPINE OR HEDGE-HOG.

One Monotreme is included in the list of specimens obtained, but the only bone yet recognised is the right humerus of a *Tachyglossus* from the older deposit. It is almost perfect, so that its comparison with other specimens is not difficult. The collection of Monotremes in the Mammalian Gallery contains several *Echidnæ* which are all somewhat smaller than the animal which yielded the bone now under review. The skeleton of *E. aculeata* is perfect, and gives ample opportunity for studying the typical bones.

It is seen at once that the Caves' specimen belongs to a larger animal, and that there are a few slight differences which are evidently only individual, as Owen's figure of the humerus of the same species, then called *E. hystrix* (pl. 14 in Phil. Trans., 1884, part 1, published in 1885) illustrates a bone which is identical with this, though slightly less in its dimensions.

*Tachyglossus (Echidna), aculeatus, var. typicus*, measurements:—

	OWEN'S <i>E. Hystrix.</i>		MAMMOTH CAVE SPECIMEN.	
	Inches.	Lines.	Inches.	Lines.
Length .. ..	2	—	2	3
Breadth (proximal end) ..	1	—	1	3
„ (middle of shaft) ..	—	4	—	5
„ (distal end) ..	1	9	2	—
Thickness of middle of shaft —	—	3½	—	4½

It will be seen from the above table that there is an all round increase in size over the specimen that supplied Professor Owen's measurements; such an increase as would easily be accounted for by the greater size of an individual of the same species. A most careful examination of this specimen and a comparison with Owen's three figures disclose two points of difference, the greater size, in regard to the whole bone, of the process known as the "tricipital" which forms the termination of the "teretial" or "posterior tricipital ridge" that runs along the radial border of the humerus from the ento-tuberosity, and secondly the greater comparative depth of the "ulnar trochlea" at the distal end of the bone. Both these features are of little importance as they would most likely become accentuated as the animal increased in age and size.

It is an interesting fact that the days which saw the *Diprotodon* and *Nototherium* in the south-west of this State, also saw this ant-eater's range much more extended than at the present time.

## ORDER MARSUPIALIA.

## SUB-ORDER DIPROTODONTIA. Fam. iii., PHASCOLOMYIDÆ.

*Phascolomys* (Geoff.)

<i>Didelphis</i> , Shaw .. ..	Gen. Zool. i., part 2, p. 504, 1800.
<i>Wombat</i> , Collins .. ..	New South Wales ii., p. 153, 1802.
<i>Phascolomys</i> , E. Geoff. .. ..	Ann. Mus. ii., p. 364, 1803.
<i>Vombatus</i> , E. Geoff. .. ..	Bul. Soc. Philom. iii., p. 185, 1803.
<i>Wombatus</i> , Desm. .. ..	N. Dict. d'H.N. (1) XXIV., p. 20, 1803.
<i>Amblotis</i> , Illig. .. ..	Prod. Syst. Mamm., p. 77, 1811.
<i>Opssum</i> , Perry .. ..	Arcana, 1811.
<i>Lasiorhinus</i> , Gray .. ..	Ann. Mag. N.H. (3) XI., p. 458, 1863.

## THE WOMBAT.

*Phascolomys Hacketti*, Sp. Nov.

(PLATES II. AND III.)

From a "blow hole" penetrating the rock upon which the main mass of the osseous deposit was situated, numerous bones and skulls of small marsupials were obtained, the largest being the remains of a wombat which had either perished in the hole, or had its body transported there before decay was so far advanced as to allow portions of the skeleton to become detached, for even the lower jaw, which is so easily lost, was present along with the other bones.

This part of the deposit was connected with a thin layer overlying the main mass and is evidently of more recent age than the material which contained the bones of *Diprotodon* and *Nototherium*.

The nature of the hole and the way in which the sand and bones were cemented together, rendered the task of recovering the specimens a matter of the greatest difficulty, and in spite of the care taken, several bones are missing. Those portions of the skeleton which have been recognised up to the present time will be described in the following order: Cranium, mandible, vertebral column, sacrum, ribs, the pelvis, the fore limbs, and the hind limbs. The bones will be compared with the figures and descriptions in the works of reference available, and their differences and resemblances noted, particularly as the examination of the skull has revealed points of difference from the recognised phascolomine species.

## THE CRANIUM.

In this specimen we note many characters which prove conclusively that this Wombat is a member of the platyrrhine group. The skull is long and strong, rivalling in size the larger example of *P. mitchelli* quoted below from the "Catalogue of *Marsupialia* and *Monotremata* in the Collection of the British Museum" (1888). The nasals are large and expanded behind, their greatest width being about five-eighths of their length, their lateral margins are undulate, as in *P. ursinus* (and also occasionally, but to a less extent, in *P. mitchelli*), and the hind borders are convex. "The angular process of the malar part of the zygoma, which defines the orbit posteriorly," is well developed, and the maxillary has that character which Prof. Owen holds to be of sufficient importance to distinguish *P. mitchelli* (*P. platyrrhinus*) from *P. ursinus* (*P. wombatus*) and which he regards as a peculiar feature of the former species; see "The Extinct Mammals of Australia," p. 316, fig. 3, and p. 317.

The infra-orbital foramen is narrow and slit-like. The characters afforded by the upper surface of the skull are practically those of *P. mitchelli*, "the upper third of the temporal fossa is formed by a longitudinal strip of the parietal, whilst the slight rising developed along the line of the parietal-squamosal suture is distinct and can be traced to the posterior surface of the skull.

The longitudinal strip of the parietal bends down less abruptly in this specimen than in the form *P. ursinus* (*wombatus*) as shown in the figures in "The Extinct Mammals of Australia," and as described on p. 305 of that work. The inter-orbital region is smooth and evenly convex, the post-orbital processes are rudimentary and the distance between their tips identical with the inter-orbital breadth; there is a fairly well developed tubercle on the lachrymal.

The extent of the naso-premaxillary suture is twice as long as the naso-maxillary one.

The occipital region and the under surface of the skull could not be examined in detail as the very hard and adhesive nature of the matrix, and the thin and delicate nature of the bone in these parts rendered any attempt at cleaning a matter of such great risk that it was thought advisable not to undertake it. The anterior palatine foramina are long and narrow, and the posterior palatine vacuities "triangular, about equal in size to one of the molars."

The measurements taken are tabulated below and compared with those given by Mr. Oldfield Thomas in the British Museum Catalogue quoted above.

## SKULL MEASUREMENTS OF PHASCOLOMYS (in mm).

Characters.	Sp. nov.		<i>P. mitchelli</i>		<i>P. ursinus</i>		<i>P. latifrons</i>	
			Aged		Adult		Aged	
Basal length .. ..	179	185	161	143	167			
Greatest breadth .. ..	139	145	135	125	144			
Nasals, length .. ..	83	81	70	62	65			
„ greatest breadth .. ..	50	55	49	46	67			
„ least breadth .. ..	18	15	15	17	29			
Inter-orbital breadth .. ..	43	63	55	50	69			
Breadth between tips of post orbital processes .. ..	43	67	60	52.5	90			
Inter-temporal constriction	36	47.5	49	40	46			
Palate, length .. ..	?	125	106	93.5	110			
Diastema, length .. ..	45?	48.5	40	31.5	46.5			
Palatal foramen .. ..	13	14	11	10	10			
Basi-cranial axis .. ..	54?	57	50	48	58			
Basi-facial axis .. ..	?	130	113	96.5	110			
Facial index .. ..	—	228	226	201	190			
Tooth series, length of .. ..	54?	57	51	47	50			

It will be seen at a glance how the new specimen differs from the forms with which it is here compared. In appearance it closely resembles *P. ursinus*, having the same shaped nasals and the narrower cranial portion of the skull, but its size (length) is so much in excess of that of this Tasmanian species that it is impossible to regard them as identical.

The common Australian Wombat is often found to have a skull equal in length, but there are many points of distinction, chief among which are inter-orbital breadth and certain other measurements of the cranium given above.

It is interesting that in spite of its slender width, the greater expanse of the zygomæ should increase the total width to such a degree that it is very little less than that of the largest Wombat in the British Museum list.

Briefly stated, though the skull of this specimen is almost as long as that of the largest quoted in the British Museum list; the inter-orbital breadth, the breadth between the tips of the post-orbital processes and the inter-temporal constrictions are appreciably less than in the much smaller *P. ursinus*.

## THE DENTITION.

None of the teeth of the upper jaw are in position, but fortunately ten of them were recovered from the "blow hole."

The **incisors**, unlike Owen's figures, have no sharp anterior edge, differing in this point from all the species described in Owen's work, their section too, being broad and oval, is rather more like that of *P. latifrons*, though the coating of enamel is of greater extent than is usual in this species; the faintness of the grooves reminds one of *P. mitchelli* (*platyrhinus*).

The **pre-molars** have the characteristic form of those of *P. mitchelli* (*platyrhinus*). They present a sub-triangular transverse section or working surface, the base being backwards, the apex forward; the inner side is shorter than the outer side, and is indented near the apex by a groove traversing the tooth lengthwise; the outer angle of the base is somewhat elongated by oblique attrition. The enamel begins anteriorly at the outer part of the apex, opposite the groove, is continued inwards and backwards, and upon the base (of the triangle) two-thirds of the way towards the outer angle, which, with the outer side of the tooth to near the anterior angle or apex, is coated only by cement.

The **molars** from M<sub>1</sub> to M<sub>4</sub> (D<sub>4</sub>-M<sub>3</sub> of Owen) are all represented in the six teeth figured, with the exception of M<sub>4</sub> (M<sub>3</sub> of Owen), which are both missing, that is if we compare them with Owen's figures of *P. platyrhinus*. On the other hand, the same authority's drawings of *P. mitchelli* show last molars which differ very little from the anterior ones, in which case it is very likely that we have examples of all the cheek teeth from M<sub>1</sub> to M<sub>4</sub>. The teeth are all more or less coated, and as they are of comparatively little value for specific determination, it was thought wiser not to attempt to clear them of matrix.

## THE MANDIBLE.

Taking Owen's figures of the lower jaws as the standard, it is seen that in *P. latifrons* the curve of the under surface is much more pronounced than in *P. mitchelli* (*platyrhinus*), and that the inner angle of the condyle is much less produced in the latifront type, or in Owen's words<sup>1</sup> "the curve of the lower jaw is deeper, the

<sup>1</sup> Owen, Osteology of the Marsupialia Trans. Zool. Soc., Vol. III, p. 304, and Vol. VIII., p. 353.

inner angle of the condyle is produced inwards, and the coronoid process higher and narrower" than in the platyrrhine species. The Cave form has an outline which agrees almost entirely with Owen's figure of *P. latifrons*, the chief variation being the shorter inner projection of the condyle. The under contour, the length of the diastema, and the depth of the jaw agree exactly with Owen's figures.

As far as the size and shape of the condyle and its inner angle, which extends inwards past the coronoids, are concerned, there is not the slightest doubt that they are most distinctly platyrrhine.

Of the alveoli of the lower incisors, that of the right tooth seems to be perfect, and recalls Owen's figures of *P. wombatus* when viewed from above, but the lateral border is nearly vertical, and does not slope backwards as is usually the case with *P. platyrrhinus*. The backward extent of the symphysis is as far as the vertical groove of the third cheek tooth, thus differing from Owen's figures of *P. platyrrhinus* and *P. latifrons*. Subsequent observers<sup>1</sup> have however, shown that this feature is so variable in individuals as to render it quite useless for specific determinations.

There seems to be no intercommunicating foramen from the entry of the dental canal to the outer surface of the base of the coronoid, and it is unfortunate that the tender nature of the bone renders it impossible to undertake the cleaning necessary to ascertain whether this really is the case.

The post-symphysial foramina are only 4mm. in a horizontal line from the posterior margin of the symphysis, a distance which is much exceeded in the usual platyrrhine Wombats.

The dentition of the mandible is very similar to that of Owen's *P. platyrrhinus*, the most noticeable variation being the rounding by wear of the anterior edges of the incisors.

## MEASUREMENTS.

The total length of the mandible	..	..	140mm. (5½ in.)
Extreme width of the mandible ..	..	..	139mm.
Length of diastema .. ..	..	..	28mm.
Length of symphysis .. ..	..	..	62mm.
Thickness (depth) under M <sub>3</sub> ..	..	..	35mm.
Length of cheek series of teeth ..	..	..	52mm.
Length of four molars (M <sub>1</sub> -M <sub>4</sub> ) ..	..	..	47mm.

<sup>1</sup> De Vis, Proc. Linn. Soc. N.S. Wales, Vol. VI. for 1891, p. 239.

## THE VERTEBRÆ.

Of the seven **cervical vertebræ** only two are represented, one of which is almost perfect, possessing, as it does, the neural spine and one of the transverse processes, which, in the words of Prof. Owen<sup>1</sup>, "show the usual character of perforation due to the union of the outer extremities of par- and di-apophyses with a rudimentary rib." Comparison with the figure on plate xcvi. (loc. cit.) suggests that these are the third and fourth vertebræ of the series.

There are numerous **dorsal vertebræ**, those from the anterior portion of the body bearing long and strong neural spines, which contrast greatly with the small delicate ones present on the two cervical vertebræ pertaining to this collection. In all there are 13 rib-bearing members, so that there are two missing from the series as represented by *P. mitchelli* of Owen, the form to which our specimen is most closely related.

The four **lumbar vertebræ**, though none of them perfect, show their characteristics with distinctness, the diapophysis are large and flat, though in the last they assume a shape more approaching that of the same process in the four sacral vertebræ and the articular processes of the neural arch are more developed than in the dorsal vertebræ. Professor McCoy noticed that in several of the fossil remains of *Phascolomys* examined by him, the last lumbar vertebra showed signs of a strong inclination to become fused with those united to form the sacrum, in fact he goes further by stating<sup>2</sup> that "in several of the specimens the neural spine of the first sacral vertebra is like our fossil, nearly as high as those of the lumbar vertebræ, contrasting with the abruptly lowered or undeveloped neural spines of the following sacra; giving the impression that the last lumbar became sacral by anchylosis with the body of the succeeding one, and by the articulation of its diapophysis with the ilia." A figure given on p. 30 of the work cited illustrates this diagrammatically.

This new species is one of the intermediate forms, for in it the last lumbar with its diapophysis is much thicker and narrower than is the case with the other three lumbar, and more nearly approaching in every way the succeeding sacra. There is, however, no

<sup>1</sup> Owen, *Extinct Mammals of Australia*, p. 297.

<sup>2</sup> Prof. McCoy, *Prodromus of the Palæontology of Victoria*, dec. vii., p. 29 (1882).



sign of any anchylosis either at the centrum or at the outer extremities of the transverse processes. On the other hand, an examination of the outer margin of the right diapophysis, which is practically intact, reveals that there was undoubted articulation with the ilium.

The **sacrum** was recovered from the deposit and luckily has suffered little from the process of separating the bone from the matrix, only the left diapophysis of the fourth sacral being absent.

Prof. Owen<sup>1</sup> considered that the form adopted by the fused diapophysis was distinct in the different species, and his figures certainly show considerable variation, but later Prof. McCoy states<sup>2</sup> "The vertebral bones forming the sacrum are singularly diverse in each of the living species of Wombat or *Phascolomys*, and were supposed to afford good specific characters, but I find the variations of individuals of each species so great that I attach no value to characters which, without this experience might seem specific."

This view is confirmed by our specimen which has singular resemblances to both the *platyrhinus* and *latifrons* types, its description is as follows:—Sacrum consisting of four anchylosed vertebræ, the posterior moiety of the first centrum considerably narrower than the anterior, which has the same width as the centrum of the fourth lumbar; the posterior portion of the centrum of the first sacral, the second, third, and fourth are all equal in width but losing considerably in height as we proceed towards the caudals. Height of the neural spine on the first vertebra about 2mm., the spine is scarcely visible on the second and entirely absent on the third and fourth, the articular processes well developed on the anterior aspect of the first sacral, but fused and more and more indistinct and rudimentary as they approach the last sacral, the posterior face of which has more perfect processes for the articulation of the first caudal. The diapophysis, all anchylosed at their distal ends, the first and anterior moiety of the second articulating with the ilium on either side. The diapophysis of the third and fourth considerably broader but much thinner than those of the second, which again have not one-eighth the volume of those belonging to the first. The vacuities between the first

<sup>1</sup> Owen, Trans. Zool. Soc., vol. 8, p. 468-9, Ext. Mam. Aust., p. 359, *et seq.*

<sup>2</sup> McCoy, loc. cit., p. 27.

and second pair of diapophysis have their longest axes at right angles to the vertebral column, whilst the two succeeding pairs have them directed anteriorly, in this way appreciably resembling *P. latifrons* as figured by Owen<sup>1</sup>. On the other hand, the form under discussion differs from both the typical examples as figured by Prof. R. Owen in the slight backward extension of the articular surfaces for the ilia, but if, as probable, the last lumbar to a great extent assumed the duties of a sacral, then the total extent would closely agree with the area shown in figure 4 of the plate just referred to. As a natural consequence of the above peculiarity, the width of the sacrum rapidly diminishes at a point one-third down the second vertebra, being considerably earlier than in Owen's example.

The following measurements are taken :—

Length of the four sacrals (bodies)	..	..	86 mm.
Width across diapophysis of S <sub>1</sub>	..	..	72 mm.?
"      "      "      S <sub>2</sub>	..	..	70 mm.
"      "      "      S <sub>3</sub>	..	..	59 mm.
Width of anterior face of centrum of S <sub>1</sub>	..	..	26 mm.
"      "      posterior      "      "      "	..	..	14½ mm.
"      "      "      "      "      S <sub>4</sub>	..	..	14 mm.
Greatest height of first sacral, S <sub>1</sub>	..	..	22 mm.
"      "      "      fourth      "      S <sub>4</sub>	..	..	12 mm.
Length of articular surface for ilium	..	..	32 mm.?
Greatest width of      "      "	..	..	19 mm.

It will be seen from the above that the Mammoth Cave sacrum differs from both Owen's figures in several respects; it resembles both forms, and would be exceedingly difficult to connect with either.

Unfortunately the **caudal vertebræ** are altogether absent from the collection, so that any assistance which they might give is missing. There is, however, no doubt that these vertebræ or any of them were not united with the sacrals, for the posterior face of the last vertebra of the sacrum and the articular processes on the degenerated neural arch show that there was no coalescence at that point.

Of the **ribs** we have very few examples; the first and second left ribs are practically perfect, but all the others that are represented are in a fragmentary condition.

<sup>1</sup> Owen, Ext. Mam. Aust., pl. xcix., fig. 1.

As none of the books at hand refer to the differences and resemblances between these portions of the skeleton of the various species of Wombat, it is of little value to go more fully into the matter.

#### THE FORE LIMBS.

The **clavicles** are either missing or have not yet been identified.

The **scapulæ** are both present in a fragmentary state: of the right one there is the bone surrounding the glenoid cavity, which has the outline of that part of the scapula of *P. latifrons*, and a small portion of the distal end, or base, of the blade, including the beginning of the spine as well as another fragment of the spine. The left scapula is more complete; the major portion of the blade is preserved, and the greater part of the spine, as well as half the acromion.

In this part of the skeleton we again see a striking example of the variability of form. There is no doubt that the general outline of the cranium of this animal is almost identical with *P. mitchelli*, but here once more the form of the part under consideration approaches more nearly to the other species, *P. latifrons*. The hind border has the same curvature, and carries a similar prominence<sup>1</sup> at the angle furthest away from the glenoid cavity; the spine is likewise thickest near its outer border, but is not as stout as the corresponding part of *P. platyrrhinus* of Owen (*P. mitchelli* of more recent authorities). The blade also is narrower in proportion to its length than in Owen's figure of *P. platyrrhinus*.

The only measurements that can be taken with certainty are:—

Length of base (vertebral costa)	..	..	50mm.
Breadth of middle of scapula	..	..	46mm.
Greatest diameter (length) of glenoid cavity	..	..	26mm.
Greatest width (antero-posterior)	..	..	19mm.

Each **humerus** is represented: the right one is perfect in its proximal three-fourths, and the other in its distal three-fourths. Whilst the slender form of the bone reminds one of the platyrrhine group, the bone is in several respects inclined to be latifront. The head of the humerus shows those characters which the size of the glenoid cavity of the scapula would indicate—namely, the articular surface is wider transversely and extends further down the shaft

<sup>1</sup>Owen regards this as one of the points of difference between the species.

Ext. Mam. Aust., page 361.

than in the figured bones of *P. mitchelli*, but the ecto-tuberosity has an outline that approaches that of the platyrrhine species. The ridge that extends about two-thirds along the inner surface of the shaft is only weakly developed compared with the striking ridge shown in the figures of the bone taken from *P. latifrons*. The "predeltoid" and the "deltoid" ridges are less prominent than in either of the figures, *P. latifrons* and *P. mitchelli* (*platyrrhinus*); the latter is even somewhat rounded, lacking the sharp profile which is so pronounced in the figures. The possible youth of the animal may account for this, although the rugged nature of the whole mass forming the prominence would not suggest this fact.

The "supinator ridge" is best seen in the left humerus, and has the straight outline associated with *latifrons*, against the curve that seems to characterise the other group. It is very slender at its proximal end, but gains rapidly in thickness to form the ectocondylar triangular surface at the distal end of the bone. The arch of the bone that stretches from the shaft to the entocondylar angle or process is more slender even than is usual in *P. mitchelli*.

The distal articular surfaces are distinctly seen, and again approach the platyrrhine type, although the difference between the two species is very slight, and hardly to be noticed in a cursory examination.

The usual extraordinary thinness of the bone above the ulnar division of the distal articular surface is somewhat obscured by matrix.

The following measurements were made :—

	P. PLATYRH. <sup>1</sup>	MAMMOTH CAVE.
Approximate length .. ..	.. 113 mm.	113mm.
Width of shaft at its proximal third ..	.. 24 mm.	21mm.
Antero-posterior thickness .. ..	.. 14.5mm.	14mm.
Long diameter of head and greater tuberosity ..	.. 42 mm.	36mm.
Short diameter across head .. ..	.. ?	15mm.
Width of distal end of humerus .. ..	.. 51 mm.	46mm.

The **radius** of the right fore-limb is present. As it varies so much from the bone figured by Prof. Owen (on Plate ci., loc. cit.), it is advisable to describe it more fully :—The bone is very slender and much more curved than the example figured by Owen. The

<sup>1</sup>De Vis, Proc. Lin. Soc. N.S. Wales, Vol. VI. for 1891, p. 240, etc., and Owen, loc. cit. (figs.); chiefly the latter work.

head of the radius, which is concave, is irregular in outline, being much less circular than the same portion of the skeleton of *P. latifrons*; the "narrow semi-elliptical convex surface," which is on the posterior edge of the head, and fits into the "radial concavity of the ulna," is not quite as deep as is shown in the figures referred to. On the other hand, the distance between this feature and the "tuberosity for the biceps" agrees exactly, though our bone is somewhat longer from end to end. This tuberosity is not by any means as prominent as in *P. latifrons*. Proceeding down the shaft it will be noticed to increase gradually in thickness, and also that it tends to assume a triangular shape—one of the angular ridges being that for the insertional fascia of the "supinator longus"—and gaining in sharpness till it reaches a small tuberosity at the distal end, just above the base of the short, thick styloid process. It is also possible to trace the rough tract on the interosseal ridge or angle, situated in relatively the same position as on the bone of the figured species.

Prof. Owen states that this bone is less thick in proportion to its length in *P. platyrhinus* (*P. mitchelli*) than in the latifront species, but in the new form it is considerably so, as may be seen from the appended measurements, besides, though Owen states that the radius is "slightly bent with the convexity forward" his figures, however, show a bone which is much less arched than this specimen, for it is impossible to place this bone in a position which, whilst giving a straight outline, shows up the features as illustrated in Owen's figures.

TABLE OF MEASUREMENTS.

FEATURES.	MEASURED ON OWEN'S FIGURE.	MEASUREMENT OF CAVE SPECIMEN.
Total length .. ..	107mm.	111mm.
Width at head (proximal end) ..	14½-15mm.	12½mm.
Width below the tuberosity for the biceps ..	10mm.	9 mm.
Width at rough tract on interosseal angle ..	13mm.	12 mm.
Width at tuberosity at distal end of bone ..	23-24mm.	22½mm.

**The Ulna.** Both the right and the left are in very good condition and therefore a satisfactory examination can be made. Owen states (loc. cit.) that the platyrhine and the latifront species resemble one another to a very great extent as far as this bone is concerned. He notices that "the ulna of *P. latifrons* differs chiefly from that of *P. platyrhinus* in the quadrate form of the long olecranon which

preserves its breadth to the truncate summit, while in *P. platyrrhinus* it contracts to that summit which is thick, obtuse and tuberosus. The hind border of the olecranon is thicker in *P. latifrons* than in *P. platyrrhinus*. The surface for the ulnar division of the humeral joint is relatively longer, narrower and more obtuse in *P. latifrons* than in *P. platyrrhinus*.

The specimen under examination is much more closely allied to the platyrrhine type in the form and size of the olecranon, and the surface for the ulnar division of the humeral joint, and as it agrees with Owen's figures in all other points further notice is unnecessary. The total length of the bone is 148mm.

No other bones of the fore limb have, as yet, been recognised, though it is quite possible that some may be present in the collection.

The sacrum has already received attention so that we may proceed to describe the **pelvis**. The upper portion of the right "os innominatum" is fairly complete, though the greater portion of bones forming the pelvis are either missing or in a fragmentary state. In the Caves specimen the bone (the ilium) is slender as in the platyrrhine type and is much more elongated than is the corresponding portion of the skeleton in *P. latifrons*.

Of the other extremity of the bone we have the end of the ischium including "the expansion of the great tuberosity" in which again there is both in extent and outline an undoubted similarity with the platyrrhine and a difference from the latifront forms.

Of the bones of the hind limbs there is the **femur** in a perfect state. Referring to this bone in examples of *P. platyrrhinus* and *P. latifrons*, Owen says, "The femur is thicker in proportion to its length in *P. latifrons* than in *P. platyrrhinus*. Both trochanters are rather more prominent, but the genuine characters of the bone . . . are closely preserved in all Wombats." This authority figures bones of *P. latifrons* only, so that there is no opportunity of comparing the specimens with drawings of that portion of the skeleton of the other species; at the same time it may be stated that the Mammoth Cave specimens are decidedly more slender than the bones exemplified by Owen's figures.

Another authority, C. W. De Vis, of the Queensland Museum, enters more fully into the shape, size and character of this bone of

the hind limb in an article<sup>1</sup> in which he discusses the correctness of the assertion that *P. mitchelli* and *P. platyrhinus* are one and the same species, and that the name *P. platyrhinus* is reduced to a synonym<sup>2</sup>. In the course of his remarks he quotes numerous measurements which, together with some collected from Oldfield Thomas' work, and others made from Owen's figures (loc. cit.) are given below in tabular form.

MEASUREMENTS (in mm.)

	Mammoth Cave specimen.	<i>P. latifrons</i>	<i>P. mitchelli</i>	<i>P. platyrhinus</i>	<i>P. ursinus</i> ( <i>wombatus</i> )
Length .. ..	159	141	168	163	155
Least transverse diameter of shaft	15.5	17	17.5	14.5	14.5
Breadth of distal end .. ..	32.5	37	39	—	—
Antero-posterior diameter of head	20	24	26	—	—
Distance between the summits of the two trochanters ..	39	41	47.5	44	40
Antero-posterior dimension of the inner condyle .. ..	31	30	36	31	29

It will thus be seen that whereas the femur of this form has a slightly stouter shaft than that of *P. platyrhinus*, being almost the same strength as the bone of *P. latifrons* figured by Owen (loc. cit.); it is shorter, the breadth at the distal end is less, as also is the space between the two trochanters. On the other hand the antero-posterior dimension of the inner condyle of this form and *P. platyrhinus* agrees. In consequence, the bone cannot be referred to any of the existing or recognised species on account of a distinct variation from any one of them.

The **tibia**. The remains of this bone are only fragmentary, We have the proximal end and a portion of the shaft of the left; and the head, distal end and almost half the shaft of the right. This is unfortunate, as the available parts are too scanty to allow of any conclusions being drawn as regards the differences and resemblances of the specimens.

This concludes the description of the identified remains of the skeleton of this animal. As already stated, it is

<sup>1</sup> C. W. De Vis, Proc. Linn. Soc. N.S. Wales, Vol. VI. for 1891, p. 240, etc.

<sup>2</sup> Oldfield Thomas. Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum, p. 214, 1888. R. Lydekker, Catalogue of the Fossil Mammals in the Collection of the Brit. Mus., part V., p. 153, 1887. Murie, Proc. Zool. Soc., London, 1865, p. 851.

possible that more bones may yet be recognised as belonging to this animal, but this is not probable, as the bones were carefully sorted out upon several occasions.

Taking into consideration all the bones examined and referred to above, there seems a close relationship between this specimen and the platyrrhine form as exemplified by Owen's *P. platyrrhinus*; on the other hand, there are striking points of difference. For instance, of the skull, those most important bones, the nasals, though longer and having a greater "least breadth" than the corresponding bones of *P. platyrrhinus*, are very slender when their greatest breadth is concerned, thus suggesting in a general way the narrower form of the cranium proper which is so marked in the post-orbital region.

The greater lateral extent of the zygomal arches, bringing up to normal the greatest breadth of the skull, is also a point that must not be overlooked.

In the mandible we have several variations, chief amongst them being the contour of the under surface.

The scapula, humerus, radius and femur all appear to vary from the corresponding bones of the continental species, so that there seems some justification for considering the Mammoth Cave form a species distinct from all of them.

#### SPECIFIC CHARACTERS.

**Skull.** Large, of the platyrrhine type, with a basal length of 179mm.; nasals large, expanded behind, but less so than in *P. mitchelli*, their greatest breadth five-eighths of their length, their lateral margins undulate, posterior border convex; width of cranial portion of skull, exclusive of the zygomæ, much less in proportion to the basal length than in the other forms; zygomal arch very large; extent of the naso-premaxillary suture twice as long as the naso-maxillary suture.

**Teeth.** Upper incisors comparatively broad, oval in section, faintly grooved; lower incisors sub-triangular in section, their breadth less than their depth; molars as usual.

**Size of the animal.** As large as *P. mitchelli*.

I have named this Wombat *Phascologomys hacketti*, in honour of the distinguished Doctor, who is Chairman not only of the Museum



and of the Caves Board, but also President of the Zoological Gardens, in order to commemorate the vast amount of time and energy that he has devoted to the advancement of science in this State.

Fam. : PHALANGERIDÆ.

Sub. Fam. : PHASCOLARCTINÆ.

*Phascolarctus*, Blainv. (1815).*Phascolarctus cinereus*, Goldf. sp.

<i>Koala</i> , G. Cuv.	..	..	..	R. Anim. i., p. 184, IV. pl. lf. 5, 1817
<i>Lipurus cinereus</i> , Goldf.	..	..	..	Isis, p. 274, 1819
<i>Morodactylus cinereus</i> , Goldf.	..	..	..	Zool. ii., p. 445, 1820
<i>Phascolarctus fuscus</i> , Desm.	..	..	..	Mamm. i., p. 276, 1820
„ <i>koala</i> , Gray	..	..	..	Griff. Cuv. An. K., p. 205, 1827
„ <i>flindersi</i> , Less.	..	..	..	Man. Mamm. p. 221, 1827
„ <i>cinereus</i> , J. B. Fisch.	..	..	..	Syn. Mamm., p. 285, 1829

## THE KOALA, OR NATIVE BEAR.

### PLATE IV.

Examination of the many small mandibles obtained revealed two which differed materially from all the others in the collection. The one, that of a full grown (adult) animal, was as perfect as could be expected, only a portion, a very small portion, of the coronoid process being wanting; the other, that of a younger individual with M<sub>4</sub> not yet up into line is more imperfect at the coronoid, and has also one of the incisors missing.

They evidently belonged to a comparatively small animal which, like the Wombat, has a remarkably broad head; the coronoid process is very much prolonged, and the condyle is a considerable distance above the level of the teeth, the angle, too, is very prominent and considerably inflected. As regards the teeth, the dental formula is as follows, for the lower jaw : I<sub>100</sub>, C<sub>0</sub>, P<sub>0004</sub>, M<sub>1234</sub>.

The incisor is narrow, sharp-edged, and deep antero-posteriorly, the premolar, a little less in length than M<sub>1</sub>, has a sharp edge that branches posteriorly into two diverging ridges. The four molars vary very little in size, the first one being the smallest; they have four tubercles or cusps in the shape of sharp curved crests which have the concave sides interiorly and the convex sides exteriorly. All these characters are associated with herbivorous animals.

A careful search through the specimens in the Museum and the figures and descriptions to be found in the works of reference available, showed that without a doubt the two mandibles are those of a Koala, or Native Bear (*Phascolarctus*). See Owen's "Extinct Mammals of Australia," fig. 11, p. 90; fig. 5, p. 152; fig. 6, p. 153; fig. 3, pl. xxxii. Also British Museum Catalogue of Marsupialia and Monotremata, pp. 209, 210, 212.

The following measurements were taken in mm.:—

					Aged	Young
Antero-posterior length .. .. .	..	..	..	..	100	80
Height (coronoid) .. .. .	..	..	..	..	70	49
Thickness behind M <sub>4</sub> .. .. .	..	..	..	..	9.5	—
Width, exterior of condyle to exterior of condyle ..	..	..	..	..	67	—
Greatest width (coronoids) .. .. .	..	..	..	..	74	53.5
Length of incisors .. .. .	..	..	..	..	11?	11
Thickness of do. .. .. .	..	..	..	..	3.5	3.5
Depth at socket .. .. .	..	..	..	..	7	6
Length of cheek series .. .. .	..	..	..	..	35	38?
Length of premolar .. .. .	..	..	..	..	6.5	7
Greatest thickness of premolar .. .. .	..	..	..	..	4.5	4.5
Length of M <sub>1</sub> -M <sub>3</sub> .. .. .	..	..	..	..	21.5	23
Length of M <sub>1</sub> -M <sub>4</sub> .. .. .	..	..	..	..	28.5	31?
Length of M <sub>1</sub> .. .. .	..	..	..	..	7	7.5
Thickness of M <sub>1</sub> .. .. .	..	..	..	..	5.5	5.5
Length of M <sub>2</sub> .. .. .	..	..	..	..	7.25	7.5
Thickness of M <sub>2</sub> .. .. .	..	..	..	..	5.5	5.5
Length of M <sub>3</sub> .. .. .	..	..	..	..	7.25	7.5
Thickness of M <sub>3</sub> .. .. .	..	..	..	..	5	5
Length of M <sub>4</sub> .. .. .	..	..	..	..	7.25	7.5
Thickness of M <sub>4</sub> .. .. .	..	..	..	..	5	5
Depth of jaw under P <sub>4</sub> .. .. .	..	..	..	..	18.5	14
Depth of jaw under M <sub>4</sub> .. .. .	..	..	..	..	22	19.5
Distance of condyle above the alveolus of M <sub>4</sub> ..	..	..	..	..	32	21
Length of symphysis .. .. .	..	..	..	..	24	?

Sub-Fam. MACROPODINÆ.

<i>Sthenurus</i> —Owen	..	Proc. Royal Society XXI., No. 141, p. 128, 1873
Owen	..	Phil. Trans. Royal Society, p. 264, 1874
Lydekker	..	Catalogue Fossil Mammals, Brit. Mus., N.H. vol. V., p. 231, 1887
De Vis	..	Proc. Linn. Society N.S. Wales, 2nd series, vol. X., p. 88, 1895
<i>Protemnodon</i> ( <i>partim</i> )—Owen	..	Proc. Royal Society XXI., No. 141, p. 128, 1873
Owen	..	Phil. Trans. Roy. Soc., p. 274, 1874
<i>Procoptodon</i> —Owen	..	Proc. Roy. Soc. XXI., No. 145, p. 387, 1873
Owen	..	Phil. Trans. Royal Society, p. 788, 1874
Lydekker	..	Catalogue Fossil Mammals Brit. Mus., N.H. vol. V., p. 231, 1887

STHENURUS OCCIDENTALIS, Sp. Nov.

[Report originally prepared for the Caves Board on the specimens originally found by Mr. E. A. Le Souef. It was not printed, and has since been revised and extended.]

It has been possible, however, to make the following measurements :—

**Diastema.** Length from posterior base of enamel of incisor to anterior edge of socket of premolar, 22.5mm.

<sup>3</sup> C. W. De Vis, Proc. Linn. Soc. N.S. Wales (2nd ser.), vol. X., p. 79, 1895.

**Cheek Teeth.** Length of entire series (in situ) from anterior edge of P<sub>4</sub> to hind edge of M<sub>4</sub> 60 to 61mm., M<sub>1</sub> to M<sub>4</sub> 44.5mm., M<sub>1</sub> to M<sub>3</sub> 32.5mm.

**Premolar** (P<sub>4</sub>), antero-posterior dimension 17mm., summit of crown 12.5mm., greatest width of anterior moiety 7mm., of posterior 9mm.

**First Molar** (M<sub>1</sub>)<sup>1</sup>, length 10.5mm., fore lobe 8.5mm., hind lobe 8.5mm.

**Second Molar** (M<sub>2</sub>), length 11.5mm., fore lobe 8.5mm., hind lobe 9.5mm.

**Third Molar** (M<sub>3</sub>), length 12.5mm., fore lobe 10mm., hind lobe 10mm.

**Fourth Molar** (M<sub>4</sub>), length 11.5mm., fore lobe 9.5mm., hind lobe 9mm.

**The Mandible**, greatest length of jaw 160mm. (from the tip of the incisor to the hind margin of the coronoid); greatest depth in front of P<sub>4</sub>, 34mm.; greatest depth at M<sub>4</sub>, 35mm.; depth behind P<sub>4</sub>, 31mm. Thickness under P<sub>4</sub>, 15mm.; behind M<sub>3</sub>, 17-18mm. Dental vascular foramen  $7\frac{1}{2}$  to 8mm. below the edge of diastema, slightly in advance of P<sub>4</sub>. A second smaller foramen below the base of posterior lobe of M<sub>1</sub>.

#### DESCRIPTION OF THE SPECIMEN.

The **incisor** much resembles the corresponding tooth of the *S. atlas* figured by Owen (Phil. Trans. 1874, pl. xxii., figs. 5 and 6), but has a relatively longer working surface, possibly on account of the greater age of the individual, and is more erect.

The **premolar** is elongately oval in horizontal section, possessing a marked constriction at a point 7mm. from the anterior basal edges, particularly on the outer aspect, which almost divides the tooth into a fore and a hind lobe; the oblique horizontal continuation of this vertical groove, inwards and backwards, gives a transversely bilobed appearance to the hinder part of the crown, and causes the lobe that represents the anterior portion of the outer aspect to form the whole of the inner surface. The posterior

<sup>1</sup> This tooth corresponds to the D<sub>4</sub> of Prof. Owen. The M<sub>1</sub> of this authority agrees with the M<sub>2</sub> of later authorities. In this table of measurements the width of the lobes of the molars is the extent of the cutting edges of the lobes.

portion of the crown is shorter than the succeeding molar, and has a broad working surface with complex transverse ridging between the inner and outer simple trenchant edges. A basal ridge is present on the inner, fore, and outer aspects; that on the front of the tooth is plain, but the other two each give rise to three swellings or ribs that pass upwards to the crown. A vertical fold in the enamel is present at the intero-posterior angle; the hind surface of the tooth is perfectly smooth and convex, both vertically and horizontally.

**The Molars** (M<sub>1</sub>-M<sub>4</sub>). The lobes are thin and almost straight, though slightly convex backwards, crests slightly concave, angles sharp, particularly on the inner edge; from the outer angle of the hind lobe, a marginal fold sweeps downwards and forwards, almost closing the mid-valley; this fold from the fore lobe forms the edge of the anterior talon. Similar branching marginal folds are present on the anterior surface of the inner angle of the hind lobe. There are several vertical folds on the fore surface of each lobe. On the hind surface they are more numerous (about nine), but are almost rudimentary. A basal ridge is present on the hind surface of each molar, that on M<sub>1</sub> being little more than a slight swelling. As a general rule the ornamentation on the posterior molars is less complicated than on the anterior ones. A longitudinal link connects the fore lobe with the hind one.

**The Ramus** is strong and powerful, it is convex vertically and slightly so horizontally. The anterior vascular foramen is slightly in advance of the premolar and of fair size, as in *S. atlas* of Owen, but the second one is placed under M<sub>1</sub> instead of beneath one of the posterior molars. The under surface of the ramus shows a distinct upward arch, the posterior portion passing up in an unbroken curve to form the under aspect of the coronoid. Of the coronoid sufficient is present to show that the anterior margin of the ascending ramus ran at right angles to the line of the teeth; the condyle is absent. The "fenestral vacuity" takes the shape of a pouch, having its opening slightly below the level of the teeth, it contains the posterior outlet of the dental canal and a fenestral foramen communicating with the inner pouch of the ramus. The symphysis is ankylosed and the diastema very short.

## SPECIFIC CHARACTERS.

Longitudinal links continuous with the outermost of the incumbent folds, low but distinct, a second link lower and very indistinct in a worn tooth; present in the mid-valley of all the molars. Posterior basal ridge absent in M<sub>1</sub> and but faintly seen in the other molars.

Mandible thick, symphysis anchylosed. Incisor inclined, posterior dental foramen below the level of the teeth, level with the ectalveolar groove. Anterior edge of coronoid process rising at right angles to the line of the teeth. Under surface of the mandible arched upwards. Diastema short. Ramus thinner than in *S. oreas* (De Vis) and deeper than in *S. atlas* (Owen).

## DIFFERENCES AND RESEMBLANCES.

*S. oreas* (De Vis)<sup>1</sup> has the same general outline as our form, the same depth of ramus and an anchylosed symphysis. On the other hand its ramus is much stouter, 22.5-25.8mm. against 17mm., and the molars broader.

*S. atlas* (Owen). This species, according to De Vis, is distinguished from the preceding by having a much more slender ramus and by the fact that the symphysis is not anchylosed. In shape, too, the ramus is "flat exteriorly, increasing in depth posteriorly. Lower contour line flat or arched upwards." Against this, our form is thick, the exterior surface is convex and the lower contour line arched upwards; the symphysis is anchylosed. Again, the incisor of the new species is much more erect and the diastema appreciably shorter. In the older form the depths of the jaw are 26.1 to 28.5mm. and 29mm.-32.7mm., against 34 and 35mm.; the teeth are smaller in the animal from the Eastern States.

## ADDITIONAL SPECIMENS.

The collection contains numerous rami and portions of rami belonging to members of this genus.

They all belong to adult or aged (Thomas) animals, having all the four molars in line and more or less worn. In consequence they give every opportunity for comparison with the type specimen

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<sup>1</sup> De Vis, loc. cit, pp. 89 and 96.

of *Sthenurus occidentalis* the species I had the honour to examine, describe and name for the Caves Board.

The most perfect specimen consists of the left ramus showing the condyle, the outer "pouch" the fenestral vacuity, the fenestral foramen, and the posterior outlet of the dental (vascular) canal; but wanting the upper portion of the coronoid process. All the cheek teeth are present, though fairly worn; of the incisors only the bases are preserved, the teeth themselves having most likely been lost in the course of the excavations. There is a complete ankylosis of the symphysis as in the type specimen.

Of the right ramus we have all the cheek teeth in good condition, but not a trace of the ascending ramus, the coronoid process.

All the measurements practically coincide with those of the type, there being only an occasional variation of less than 1mm. Judging by the amount of wear exhibited by the teeth, the animal evidently attained a considerable age before it met its death.

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A second specimen consists of the practically complete left mandibular ramus comprising the incisor, all the cheek teeth, practically all the coronoid, the condyle, and what is so often missing, the angle, in this case almost intact.

The specimen is evidently a *Sthenurus occidentalis*, almost every measurement agreeing with the type.

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There are two additional specimens consisting of the four molars of the right and left ramus respectively, in which all the teeth show signs of wear, the dentine being exposed in M<sub>1</sub>, and also slightly in M<sub>2</sub>. The whole series measure 47mm. against 45mm. in the type, but I have no doubt that these two belong to the same species, being simply the remains of a larger individual. There is no appreciable difference in the tooth sculpture between these and the type molars.

Lastly, there is a specimen comprising the four molars, the last almost in place, the base of the coronoid and the posterior portion of the horizontal ramus which is of interest, as the teeth have a somewhat different type of ornamentation from that of the previous rami and are somewhat smaller. The ramus, too, is more slender and has a decided angle at the posterior lower end of the horizontal ramus in place of the graceful curve that characterises *S. occidentalis*. In these respects it resembles the right ramus of a young individual obtained in the cave when the deposit was discovered some years ago.

These rami of young examples of *S. occidentalis* are of value, as they allow us to form a better idea of the appearance of fresh and unworn molars.

The type specimen is the mandible of an old individual, rendering the accurate description of these teeth rather difficult. It is gratifying to be able to state that a careful examination of the teeth of these younger examples has confirmed the statements made in my report to the Caves Board of W.A. some months ago. The only additional feature to which attention may be drawn being the fact that the outer aspect of the "external incumbent fold on the fore lobe which sweeps round to form the sharp ridge along the anterior talon of the tooth," is ornamented with two or three vertical folds which are most prominent on the true molars, M<sub>1</sub> to M<sub>3</sub>, and only rudimentary on M<sub>4</sub>.

The angle at the base of the coronoid of the younger individuals to which reference was made above, is a character which loses its sharpness as the animal increases in size, for we have several intermediate stages from a young animal with its deciduous molars, D<sub>2</sub>-D<sub>3</sub>, still in position, to the aged individual that has had its last molar (M<sub>4</sub>) in use for some considerable time. As might be expected, these younger animals have a ramus which is considerably shorter, shallower, and much more slender than that of a full grown member of the same species. It must also be added that their teeth, too, possess a rather smaller "crown only" measurement, as they are comparatively speaking unworn and preserve all the sharp edges of the crowns or ridges of the lobes, the links, talons and folds.



## MUSEUM NOTES.

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### SOME IMPORTANT ADDITIONS TO THE COLLECTIONS RECEIVED SINCE 1st JULY, 1909.

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**Zoology.**—Sir Ernest H. Shackleton, C.V.O., has presented a Crab-eating Seal, *Lobodon carcinophagus*, and an Emperor Penguin, *Aptenodytes forsteri*, collected on the South Polar Expedition. Mr. Gregory Mathews has sent, in exchange, specimens of the Tinamous, *Tinamus latifrons*, and of the Sand-grouse, *Pteroclis bicinctus*, examples of two orders of birds not hitherto represented.

**Botany.**—Mr. J. H. Maiden, F.L.S., the Government Botanist of New South Wales, has given specimens of two new gums, *Eucalyptus woodwardi* and *E. morrisoni*, which were collected by Mr. Henry Deane, M.A., far to the East of Kalgoorlie during the Transcontinental Railway Survey.

**Mineralogy.**—A series of Antarctic rocks, of lava and pumice from Mt. Erebus, forwarded by Professor T. W. E. David, of Sydney University, on behalf of the donor, Sir Ernest H. Shackleton, C.V.O. Various W.A. rocks, ores etc., from residents in this State.

**Paintings.**—The late Hon. Sir George Shenton, Kt., has bequeathed the oil-colours "Evening on the Sussex Downs," by A. F. Grace, and two seascapes, County Clare, Ireland. A Portrait of a Lady of the Court of Louis XIII., by Phillippe de Champaigne (1602-1674), and the "Widow's Acre," by G. H. Boughton, R.A. (1834-1905), have been purchased on the recommendation of Sir James D. Linton, P.R.I. The Hon. Dr. J. W. Hackett has presented three oil paintings, a Sketch on the Normandy Coast, by J. W. Morrice, a Canadian artist; the "Reprimand," by Henriette Browne (Madame Jules de Saux) (1820-1904); and "Loves me, loves me not," by E. Phillips Fox. "A Feather fallen from the Wings of Cupid," by Rupert C. W. Bunny, has been purchased. Messrs. Fox and Bunny are the first two

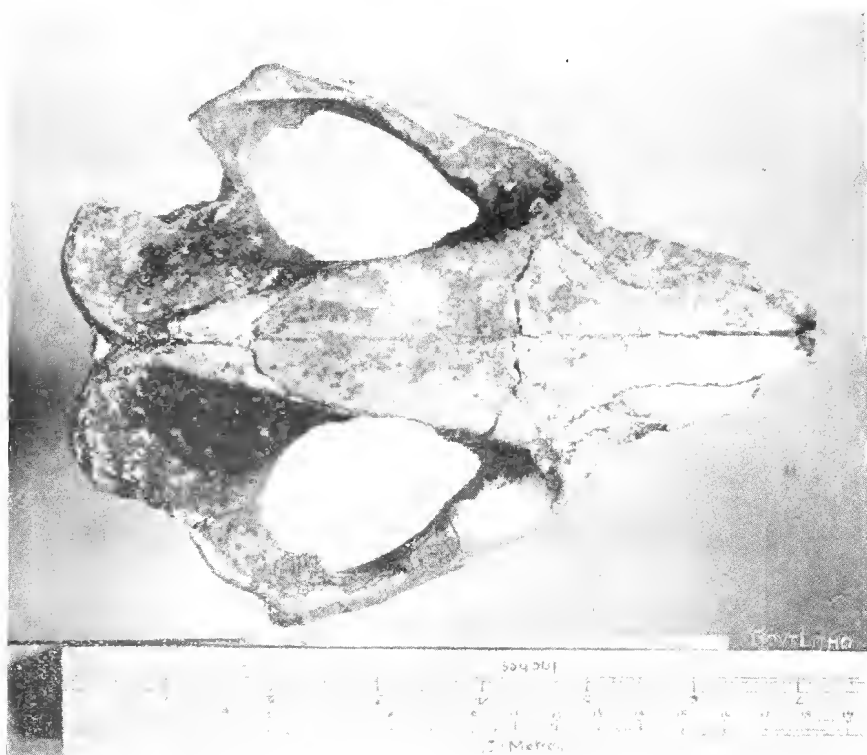
Australians to have attained the distinction of election as Associés de la Société des Beaux Arts in Paris. The Gallery is indebted to Sir James D. Linton, P.R.I., for the present of a charming "Portrait of a Lady" by Sir Wm. Beechey, R.A. (1753-1839).

**Arts and Crafts.**—The Imperial Academy of Science at St. Petersburg has sent out a very valuable collection of Russian porcelain, which includes a statuette, "Lost in Thought." These have been acquired in exchange for native weapons and other duplicate specimens.

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N.B.—With the exception of the Frontispiece, the plates were made by Mr. H. J. Pether, the Government photolithographer, from photographs taken by Mr. G. Pitt Morison, of the Museum. It has been found necessary to print each block on a separate page, therefore there are two each of Plates II., III., and V.

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*Phascotomys hacketti* (sp. nov.)

PLATE II., FIG. 1.—TOP VIEW OF SKULL.

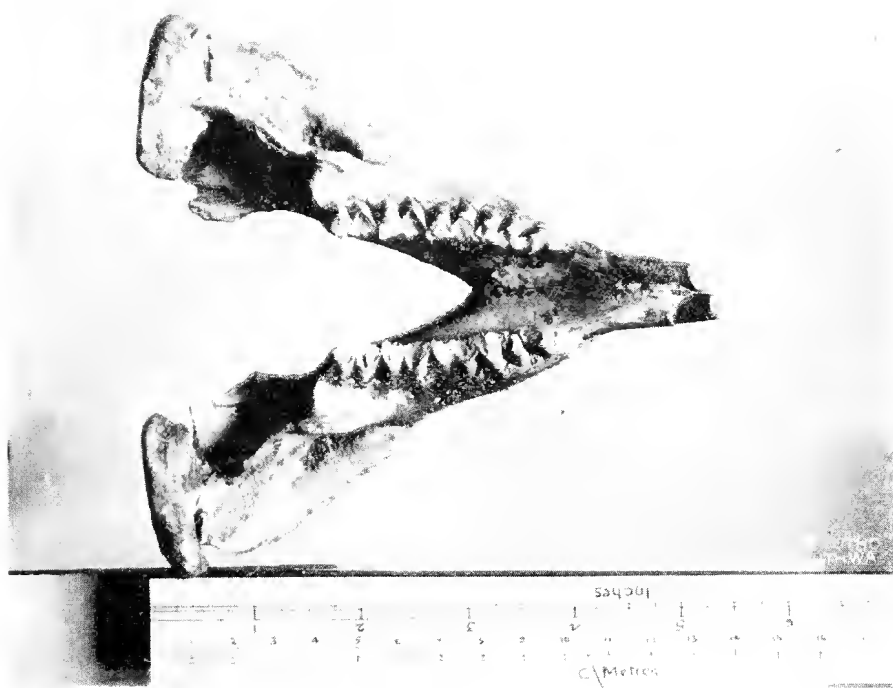




*Phascolomys hacketti* (sp. nov.)

PLATE II., FIG. 2.--TEETH OF UPPER JAW.





*Phascolomys hacketti* (sp. nov.)

PLATE III., FIG. 3.—TOP VIEW OF MANDIBLE.



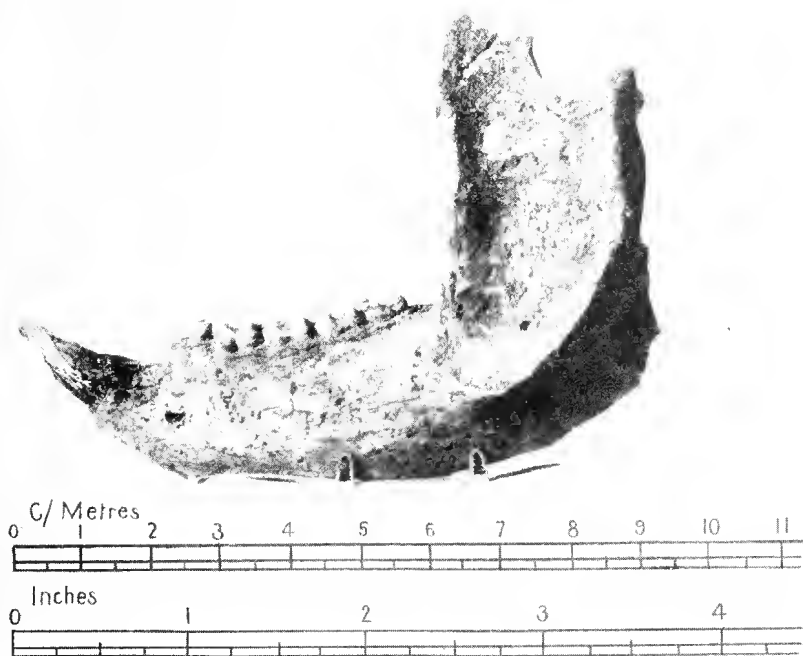




*Phascolomys hachetti* (sp. nov.)

PLATE III, FIG. 4—SIDE VIEW OF MANDIBLE.

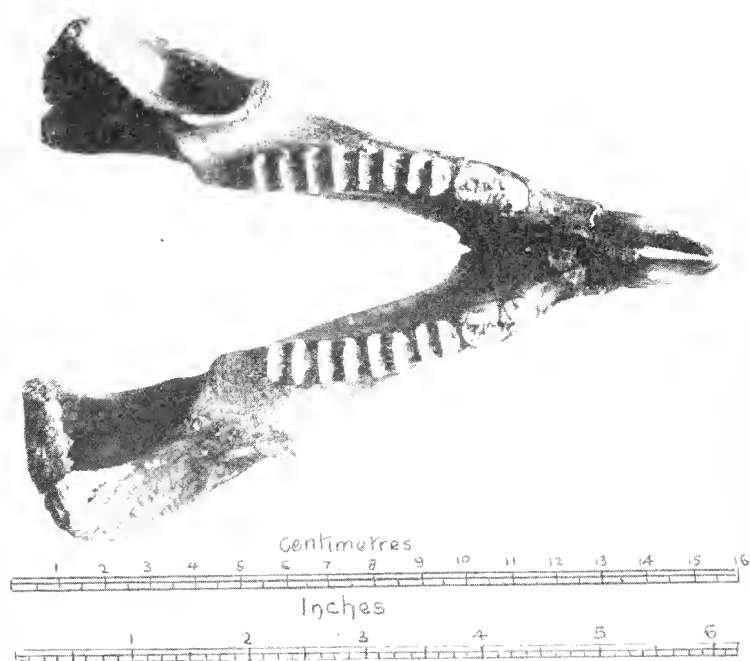




*Phascolarctus cinereus* (Goldf. sp.)

PLATE IV., FIG. 5.—SIDE VIEW OF MANDIBLE.

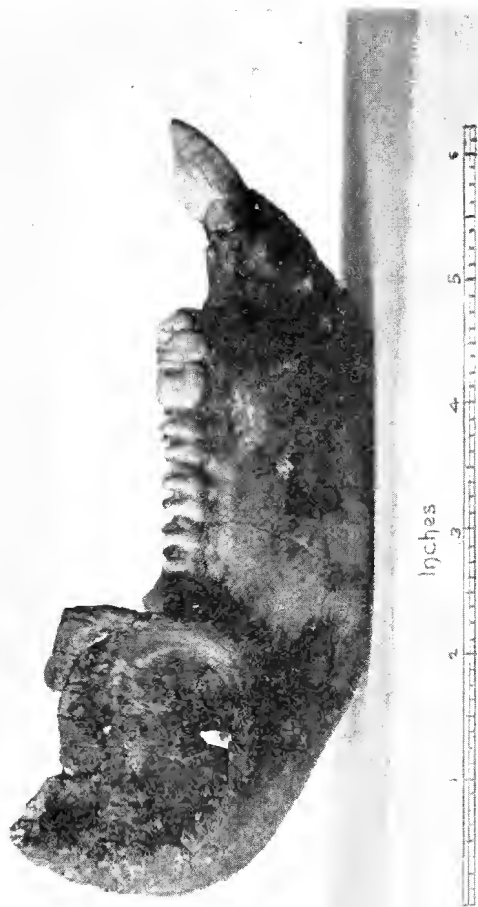




*Sthenurus occidentalis* (sp. nov.)

PLATE V., FIG. 6.—TOP VIEW OF MANDIBLE.





*Sthenurus occidentalis* (sp. nov.)

PLATE V, FIG. 7.—SIDE VIEW OF MANDIBLE.







# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM AND ART GALLERY

EDITED BY THE DIRECTOR,  
BERNARD H. WOODWARD, F.G.S., C.M.Z.S.

## VOLUME I. PART II.

### CONTENTS:

	PAGE
The Mammoth Cave ( <i>Contd.</i> ), by L. Glauert, F.G.S.	39
Fossil Remains from Balladonia in the Eucla Division, by L. Glauert, F.G.S.	47
Determination of the Exact Localities where Cambrian Fossils were collected by E. T. Hardman in 1884, by L. Glauert, F.G.S.	66
Note, by the Editor	73
Permo-Carboniferous Fossils from Byro Station, Murchison District, by L. Glauert, F.G.S.	75
Notes on Some Western Australian Fishes, by Allan R. McCulloch, Zoologist, Australian Museum	78
A Visit to Bernier and Dorré Islands during August and September, 1910, by Otto Lipfert	98
List of Birds observed on Dorré and Bernier Islands, by Otto Lipfert	100
Museum Notes.—The Trustees Act	102
Recent Additions to the Collections	103

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# THE MAMMOTH CAVE

(Continued).

By LUDWIG GLAUERT, F.G.S., ETC.

1. MAXILLARY TEETH OF A NEW VARIETY OF *NOTOTHERIUM*.
2. REMAINS OF *DIPROTODON AUSTRALIS* (OWEN).

ORDER MARSUPIALIA.

SUB-ORDER DIPROTODONTIA.

Fam. PHALANGERIDÆ.

Sub-Fam. NOTOTHERINÆ.

*Nototherium*, Owen (1845)<sup>1</sup>.

*Nototherium*, sp.

Syn. *Zygomaturus*, De Vis, Proc. Royal Soc., Queensl., Vol. V., p. 114, 1889.

## NOTOTHERIUM.

(PLATE VI., Figs. 8, 9, 10)

The genus *Nototherium* was established by Prof. Owen in 1845, and comprises animals which are somewhat less in size than the better known genus *Diprotodon*.

The animal closely resembled its larger companion, but also had many points in common with the Wombat (*Phascolomys*). In referring to the limb bones and skeleton, Lydekker<sup>3</sup> states: "The limbs are of equal length; the humerus has an entepicondylar foramen, and closely resembles that of *Phascolomys*; the olecranon is well developed, and the other limb bones and vertebræ are of the type of those of the latter genus. The structure of the feet is not fully known, but it apparently approximated to that of *Phascolomys*."

This family (the *Nototheriidae*) connects the *Phascolomyidae* with the *Diprotodontidae*; the cranium, limb bones, and vertebræ being

<sup>1</sup> Rep. Brit. Ass. Adv. Sci. for 1844, XIV., pp. 231-235, 1845; and Cat. Mamm. and Aves, Mus. Royal Coll. Surg., p. 314, 1845.

<sup>2</sup> Cat. Foss. Mamm. Brit. Mus. (N.H.), Part V., page 161.

nearest to those of the former, the mandible showing characters common to the two, while the cheek-teeth are of the type of the latter.

It is easy to see how the structure of the cheek-teeth could pass into that of the *Phascotomyidæ*; and it is not improbable that the two families may have diverged from a common ancestor.

The structure of the humerus apparently indicates fossorial habits."

Two teeth from the upper jaw of a large *Diprotodontoid* marsupial were obtained from the lower stratum.<sup>1</sup> The one tooth is a premolar and the other a molar. They both belong to the left series.

The bilobed molar (plate vi., figs. 8 and 9) has a rhomboidal outline, narrower posteriorly, with the angles obtusely rounded; the anterior surface and the sides measure from 35 to 36mm. in linear extent, the length of the posterior face is 32mm.

The two lobes of the tooth are parallel and *en échelon*, the hind lobe projects farther inwards and is rather shorter and narrower; each lobe shows a slight swelling at the inner extremity, is convex on the anterior face and concave backwards. The crest of each lobe is obliquely truncated, the exposed dentine sloping anteriorly. As the fore lobe is more worn than the hind one it has developed a larger tract of bared dentine.

Distinct anterior and posterior basal ridges are present, each terminates in a tuberosity at its outer end, and does not ascend the outer side of the lobe. The posterior ridge and tuberosity are less developed than the anterior ones. The inner continuation of the anterior basal ridge ascends the interior face of the lobe, gradually diminishing as it approaches the summit, on the posterior face of this lobe it descends to form a ridge closing the inner end of the mid valley, it then rises on the fore side of the hind lobe, subsiding towards the summit. A continuation of the posterior basal ridge rises upon the interior face of the hind lobe. On the outer aspect of the tooth a distinct isolated ridge closes the outer end of the mid valley.

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<sup>1</sup> *Ante* p. 12.

At a point in the mid valley of the tooth, about one-fourth from the outer border, a slight swelling or rudimentary link connects the two lobes, from this point the surface of the valley slopes gradually to the inner and outer confining ridges.

The unworn enamel seen on the floor of the mid valley and near the anterior and posterior ridges is punctate.

The tooth differs from the upper molars of the two species of *Diprotodon*, *D. australis* (Owen) and *D. minor* (Huxley) in having its lobes placed more obliquely across the tooth, in the inward projection of the posterior lobe and the form of the anterior and posterior basal ridges. The upper molars of *D. australis* (Owen) are also much larger.

Prof. Owen's genus *Nototherium* possesses upper molars with obliquely directed lobes, anterior and posterior basal ridges, enclosed mid valley and enamel punctate when unworn. The second upper molar (M1 of Owen's monographs), as described and figured, agrees with the tooth under consideration in size, outline, and ornamentation, but the anterior basal ridge is stated to be "continued at both ends upon the corresponding border of the anterior lobe<sup>1</sup>" without a tuberosity externally.

In view of the close resemblance, this molar has been identified as belonging to a species of *Nototherium* and the presence of the tuberosity on the anterior basal ridge regarded as an individual or specific character.

The premolar (plate vi., fig. 10) may be described as under:—

Outline sub-triangular, the outer side being the longest. The anterior portion, or talon, is occupied by a cusp having the form of an equilateral triangle with one of the angles situated posteriorly and a slightly rounded side forming the anterior aspect. The crown of the tubercle is worn obliquely, so that the dentine is slightly exposed. This surface is considerably lower than the posterior portion of the tooth, showing that the opposed tooth of the mandible must have had a bulky anterior prominence such as shown in all Owen's figures of D3 of the lower jaw of *Nototherium*.

<sup>1</sup> Phil. Trans. Royal Soc., Part 1, 1872, p. 68; and Ext. Mamm. Australia, p. 276, 1877.

The rest of the tooth consists of two ridges at right angles united in front and enclosing a simple valley behind. The outer ridge occupies about two-thirds of that side of the tooth and contains an anterior tubercle, the enamel of which is partly worn away, exposing a ridge-shaped surface of dentine having its apex posteriorly. The interior angle of the tooth is occupied by a tubercle which, too, is so worn as to expose the dentine; in this instance also triangular, but with the base situated intero-posteriorly and covering a much larger area than the other two patches already referred to. The surface of this patch is much lower than the others and slopes so that the base is considerably lower than the apex of the triangle. There is a slight swelling at the base of the posterior aspect which may represent a rudimentary cusp or tubercle.

The anterior tubercle is divided from the posterior crown by two valleys, each falling from a slight bridge which connects this cusp with the rest of the tooth and each closed by a slight ridge. The valley enclosed by the two posterior ridges slopes very abruptly to the posterior margin of the tooth, where it also was enclosed by a confining cingulum or ridge which has its origin at the base of the anterior tubercle of the longitudinal ridge; it runs along the base of the exterior, and at the extero-posterior angle rises half way up to the summit of the tooth, then it again descends to enclose the posterior valley, and appears to ascend to the present worn surface of the internal tubercle. It can then be traced down the anterior face, across the mouth of the antero-internal valley and into the mass of tubercle of the anterior talon.

The fangs are typical of *Diprotodon* and *Nototherium* premolars. The premolars of *Diprotodon* and *Nototherium* have led to a great amount of confusion. The milk teeth have been mistaken for permanent ones, and teeth of the one genus have been ascribed to animals of the other. The upper premolar (D3 of Owen) of *Diprotodon* is not often found in the jaw as, being deciduous, it is shed as the animal approaches maturity. Prof. Owen figures a tooth from the lower jaw<sup>1</sup> in its natural position—taken from a sketch transmitted to him by a Dr. E. A. Hobson—which shows

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<sup>1</sup> Ext. Mamm. Australia, p. 204, 1877

that, like the permanent cheek teeth, it consists of two lobes separated by a mid-valley. From the state of wear of the crown, this great authority considered that the upper premolar also had two parallel lobes. The following tooth (*D*<sub>4</sub> of Owen) has a somewhat similar shape, but is of greater size.

Prof. Owen was so thoroughly convinced of the accuracy of his determinations and conclusions that he never agreed with the views expressed by Prof. Huxley<sup>1</sup>. As late as 1877 he states<sup>2</sup>: "The *Diprotodon minor* of Huxley is founded on the teeth of the species of *Nototherium*." It will be seen he did not fall in with the suggestion that there had been a second, smaller species of *Diprotodon* coeval with the larger *D. australis*, but stated most positively that the specimens to which Prof. Huxley referred were really species of *Nototherium* (*N. mitchelli* and *N. victoriae*).

At a later date De Vis, when attempting to identify and name the large number of Pleistocene marsupial remains in the Queensland Museum, was able to extend our knowledge of the identity of these premolars. In 1888 he sent a contribution to the Royal Society of Queensland "On *Diprotodon minor* (Huxley)<sup>3</sup>," in which he summarises his conclusions in the following terms<sup>4</sup>: "The premolars figured by Prof. Huxley are unmistakably teeth of *Diprotodon*. The distinctness of the animal they represent from *D. australis*, affirmed with some reserve by Prof. Huxley, and practically without reserve by Sir R. Owen, is confirmed by fresh evidence. The differences between the three premolars made known are reconcilable, the difficulty raised by them less than that of admitting three allied species in the same habitat. They represent one form, *D. minor*, which is a species, and not the female of *D. australis*. The genus therefore contains two Queensland species, *D. australis* (Owen) and *D. minor* (Huxley) "

The plate which illustrates the conclusion of De Vis shows the upper premolars of *D. australis* and of *D. minor*—this latter including the *D. australis* (?) of Prof. Huxley's contribution of 1862. The

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<sup>1</sup> Quart. Journal Geol. Soc., XVIII., p. 422, *et seq.*, 1862.

<sup>2</sup> Loc. cit., p. 511.

<sup>3</sup> Proc. Royal Soc. Queensland, Vol. V. 1888; p. 38, 1889.

<sup>4</sup> Loc. cit., p. 44.

two parallel lobes are a striking feature in the premolar of *Diprotodon* and can be seen in every figure. As they are not present in the Mammoth Cave premolar, it is impossible to regard this tooth as belonging to this genus.

Premolars of *Nototherium* as well as the upper premolar of Macleay's *Zygomaturus trilobus*, are figured by De Vis in the same volume.<sup>1</sup> The Mammoth Cave premolar is unlike the *Nototherium* or *Owenia*<sup>2</sup> teeth shown, and differs from the *Zygomaturus* tooth in the absence of the posterior cusp. In fact, the tooth has a triangular outline like *N. inerme* shown in figure 5, plate XLIII., of Owen's "Extinct Mammals of Australia," which it resembles more than the other *Nototherium* premolars shown on plate LXXXVIII., figures 11-17, or in miniature on plates XXXVI. and XXXVII., or in full size in figures 3 and 4, plate XLIII. It differs, however, from Owen's *N. inerme* in several important points. This author describes the upper premolar of that species as follows, on p. 277. The tooth "is relatively smaller and less complex on the grinding surface than in the corresponding tooth in *N. mitchelli*, the transverse and antero-posterior diameters are alike. The outer lobe or division has one coronal prominence upon which a slender triangular tract of dentine is exposed on the shorter, inner lobe; an anterior and a posterior basal ridge bounds corresponding depressions divided by the confluence of the apices of the outer and inner divisions at the centre of the crown; a short external basal ridge closes the concavity impressed upon the hind half of the outer surface of the crown." Owen described (loc. cit., p. 275) the tooth D<sub>3</sub> of the upper jaw of *N. mitchelli* in the following terms. The tooth "may be said to be two-lobed, but is divided in an opposite direction to that in the rest of the series, viz., into an outer and an inner, rather than a front and a back lobe. The working surface is sub-triangular in form, the angles obtusely rounded . . . The outer lobe or division is the chief one and constitutes the outer two-thirds, and the whole fore-and-aft extent of the tooth; the outer side of its base swells out like part of a cingulum or ridge; the summit is sub-compressed and seems to have been trituberculate; the inner and lower division consists of a larger hind tubercle and a smaller front one. . . . It is

<sup>1</sup> Proc. Royal Soc. Queensl., Vol. V., 1888, p. 111, *et seq.*, and plate —, 1889.

<sup>2</sup> Renamed "Euowenia," as "Owenia" was previously occupied.



implanted by two roots, one behind the other, the posterior one being the larger and grooved anteriorly, as if preparatory to further transverse subdivision." De Vis defines the upper premolar of *Zygomaturus* in these words<sup>1</sup>: "Its posterior two-thirds are occupied by a longitudinal ridge on the outer side, and two tubercles on the inner, the outer ridge and anterior tubercle being joined by a low link over which passes the longitudinal sulcus dividing the ridge from the tubercles. The anterior third supports a single large tubercle or rudimentary lobe."

The Mammoth Cave tooth is thus seen to resemble this premolar very closely, differing only in the state of development of the posterior tubercle of the hind lobe; in the *Zygomaturus* of De Vis it is prominently shown, but in the tooth from the Mammoth Cave it is only rudimentary.

Mr. Lydekker states<sup>2</sup> that the premolars of *Nototherium* are very variable, and therefore includes under one specific name Owen's various forms of *Nototherium* as well as the fossils known as *Zygomaturus trilobus* by some authorities. This tooth is therefore classed at the upper premolar of *Nototherium*, and to show its close affinity to the *Zygomaturus* premolar the name *Zygomaturus* is entered as a synonym.

There seems no doubt that the molar and the premolar from the Mammoth Cave have both belonged to the left upper tooth series of the same animal, a species of *Nototherium*.

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<sup>1</sup> Loc. cit., p. 114.

<sup>2</sup> Ann. and Mag. Nat. Hist., series 6, Vol. III., p. 149, *et seq.*, 1889.

Sub-Fam. DIPROTODONTINÆ.

*Diprotodon*, Owen (1838)<sup>1</sup>

*Diprotodon australis*, Owen (1838)<sup>2</sup>

## THE DIPROTODON.

There are many fragments of large bones which are very difficult to identify, but it is not at all unlikely that a number of them belong to this species, the largest Australian marsupial.

Up to the present, those specimens which undoubtedly belong to *D. australis* consist of the head of a femur, several fragments of the ilium, including the socket which received the head of the thigh bone.

It is quite possible that some of the other fractured and much decayed bones and bone fragments may belong to this animal, but there is so little material of value to work on that it would be too hazardous to express any opinion on the subject of their definite identity. Some of the portions of ribs certainly are of very great size, and seem to have belonged to an animal quite as large as the creature which yielded the bones from which the cast of the *Diprotodon australis* skeleton in the Mammalian Gallery was taken.

A number of bones in a more perfect state of preservation but presumably all belonging to a smaller animal, have also been classed as bones of *D. australis*. They comprise radius, ulna, femur, clavicle, imperfect ribs, and cervical vertebræ—of these, the limb bones show all the *Diprotodon* features. The olecranon of the ulna is short, not prolonged as in *Phasconomys* (the Wombat), and the radius has a characteristic twist.

The dimensions of the limb bones are as under:—

Total length of ulna, including the olecranon	..	36	cm.
"    "    radius	..	32.5	cm.
"    "    femur	..	about 46	cm.

They are much smaller than the corresponding bones of *D. australis*, when fully grown, but evidently do not belong to the *Nototherium* whose teeth were found in the deposit, as the ulna and radius do not indicate fossorial habits.

<sup>1</sup> In Mitchell's "Three Expeditions into Eastern Australia," 2nd Edition, Vol. II., p. 362 (1838).

<sup>2</sup> Loc. cit.

## FOSSIL MARSUPIAL REMAINS FROM BALLADONIA IN THE EUCLA DIVISION.

### THE BALLADONIA "SOAK."

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The Balladonia Soak, which has yielded the rich variety of fossilized animal bones and teeth about to be described, is situated at the foot of the outcrop of the Granite Rocks at Balladonia, in the Eucla Division of this State. These rocks cover an area of approximately 200 acres, and rise to a height of about 50 ft. above the surrounding limestone plain.

During the rainy season the water from this catchment area drains into the encircling superficial deposits, where it is retained for some considerable period. In this, as in many other soaks, the loss by drainage and evaporation during the year is less than the quantity of water yielded by the annual rainfall, so that the store of water is practically permanent in character.

In the winter time the rocks are surrounded by an expanse of water, which gradually decreases in area and becomes fringed by a border of swampy land, in which animals often become entombed in their efforts to reach the pools of water beyond.

Carnivorous animals such as *Thylacoleo* and *Sarcophilus* would also make the country surrounding the water their haunt, and in addition to their own remains, would leave behind them bones of the animals upon which they preyed. That both *Thylacoleo* and *Sarcophilus* lived in the locality is proved by the presence of their bones and teeth among the other remains presented by Messrs. Wm. Ponton and John Sharp of Balladonia. Broken bones with undoubted tooth-marks upon them have been recognised, but up to the present it has not been possible to make those careful and painstaking investigations necessary to determine the identity of the animal which left the markings upon the fragments. When opportunity offers, however, experiments similar to those recorded

by Prof. Baldwin Spencer and Mr. R. H. Walcott, in the proceedings of the Royal Society of Victoria, Vol. XXIV., Part I., 1911, pp. 92-123, will be undertaken.

The Museum and Science generally are greatly indebted to Messrs. Wm. Ponton and John Sharp for these collections, the value and significance of which cannot be estimated until all the specimens have been subjected to examination.

Up to the present eight species of extinct Marsupials have had their range extended into Western Australia, and of these several do not appear to have been recorded in the adjoining State of South Australia.

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#### ORDER MARSUPIALIA.

SUB-ORDER POLYPROTODONTIA. Fam. DASYURIDÆ.

*Sarcophilus*, Cuv. (1838) <sup>1</sup>.

*Sarcophilus lanianus*, Owen (1838). <sup>2</sup>

*Dasyurus lanianus*—Owen .. Owen in Mitchell's "Three Expeditions into Australia," 2nd edition, Vol. II., p. 363, 1838.

*Sarcophilus lanianus*—Owen .. Lydekker Cat. Foss. Mamm. Brit. Mus., Pt. V., p. 265, 1887.

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### SARCOPHILUS LANIARIUS.

This species is represented by eight specimens, the most perfect being a portion of the skull comprising the maxilla and part of the premaxilla with the right upper tooth series from I<sub>3</sub> to M<sub>4</sub> and showing a portion of the outline of the infraorbital foramen and the palatal vacuity. This specimen agrees in size with Prof. Owen's figures on Plate V. of Ext. Mamm. Aust. The length of space occupied by M<sub>1</sub> to M<sub>3</sub> is 39mm.

Four other fragments show portions of the upper tooth series; in every case the teeth are well worn, the animals to which they belonged were therefore adult or aged. The largest specimen has the infraorbital foramen perfect.

A piece of the left lower jaw shows the four molar teeth in

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<sup>1</sup> F. Cuvier. Hist. Nat. des Mammifères, pl. 70, 1838.

<sup>2</sup> Sir T. Mitchell's "Three Expeditions into the Interior of Eastern Australia," 2nd edition, Vol. II., p. 363, 1838, as *Dasyurus lanianus*.

position, one of them perfect and the others more or less damaged. The mandible agrees in dimensions with Owen's figured specimens and exhibits the posterior predental foramen beneath the fore part of the second molar ( $M_3$ ) as in the type.

The three remaining specimens, a right mandible with sockets of the four molars, the anterior portion of the right lower jaw with the teeth  $P_1$ ,  $P_3$  and  $M_1$  and a fragment containing in situ the canine ( $C$ ) and the two premolars ( $P_1$  and  $P_3$ ) bear a strong resemblance to the *S. ursinus* described by McCoy<sup>1</sup>; they all show a posterior predental foramen below the anterior part of the first molar as is usual in this species, but in view of the opinion expressed by R. Lydekker<sup>2</sup> have been classed as *S. laniarius* (Owen).

This species has not previously been recorded for Western Australia.

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#### SUB-ORDER DIPROTODONTIA.

Fam. PHALANGERIDÆ.      Sub-Fam. DIPROTODONTINÆ.

*Diprotodon*, Owen (1838)<sup>3</sup>

*D. australis*, Owen (1838)<sup>4</sup>

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### THE DIPROTODON.

The abundance of remains of *Diprotodon* found in deposits similar to those of Balladonia would suggest that a number might be expected in the soils at that locality.

Although the bones presented by Messrs. Ponton and Sharp are all fragmentary, it has been possible to identify many of them as belonging to this animal. They include fragments of ribs, vertebræ, shoulder blades, leg bones and the pelvis, as well as small portions of the maxilla and mandible containing the roots of cheek teeth.

The first lot of specimens, consisting of teeth only, had been exposed to the surface for a considerable period, and were, therefore,

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<sup>1</sup> Prodomus of the Palæontology of Victoria, Decade VII., pp. 11-13 and figures on Plates LXII. and LXIII., 1882.

<sup>2</sup> Catalogue of the Fossil Mammals in the British Museum (N.H.) Part V., p. 265, 1887.

<sup>3</sup> In Mitchell's "Three Expeditions into Eastern Australia," Vol. II., p. 362, 1838.

<sup>4</sup> Loc. cit.

very much weathered. They were, without exception, the teeth of a full grown and aged animal, as they showed signs of having been in use for some time. In all of them the dentine is exposed to a marked extent, some even have all traces of the original mid-valley obliterated. The teeth indentified include the first incisor and the first, second and fourth molars of the upper jaw, and the incisors and first true molar (M1) of the lower.

The whole series of specimens so closely resemble the figures in Owen's various papers<sup>1</sup> that there is no doubt that they belong to *Diprotodon australis*.

Remains of *Diprotodon* have been found in various localities. In 1883, the late E. T. Hardman<sup>2</sup> collected a leg bone in the Lennard River, near the Devil's Pass in West Kimberley; in 1892, the Elder Exploring Expedition<sup>3</sup> obtained a fragment of a bone in the Great Victoria Desert; Mr. F. R. Arthur found the greater part of a mandible to the west of Lake Darlôt in 1895<sup>4</sup>; and in 1909 the writer had the good fortune to uncover a number of fairly perfect *Diprotodon* bones in the Mammoth Cave, near the Margaret River. Teeth however, are now recorded for the first time, and are a valuable addition to our knowledge of the West Australian form of the species, the identity of which is now beyond doubt.

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<sup>1</sup> In Phil. Trans. Royal Soc.

<sup>2</sup> Hardman's Report on Geology of the Kimberley Districts 1884, p. 21:—"this bone was identified by the late Prof. McCoy as the long head of a femur of *Diprotodon australis*."

<sup>3</sup> Dr. E. C. Stirling, Director, National Museum, Adelaide, S.A.

<sup>4</sup> This specimen is in the Museum Collection.

## SUB-FAMILY PHASCOLOMYINÆ.

*Phascolonus*, Owen (1872).<sup>1</sup>*Phascolonus gigas*, Owen (1859).*Phascolomys gigas*—Owen .. Encyclopædia Britannica, 8th Edition, Vol. XVII., p. 175, 1859.*?Sceparnodon ramsayi*—Owen .. Proc. Royal Soc., XXXVI., No. 228, 1884, Phil. Trans. Royal Soc., Vol. CLXXV. pp. 245-248, 1885.

## GIANT WOMBAT.

This animal is represented by a number of teeth, of which several are practically perfect. They include the right lower premolar (PM<sub>4</sub>), the right lower first molar (M<sub>1</sub>), the left lower first molar (M<sub>1</sub>), a lower molar which could not be definitely placed, and seven or eight fragmentary cheek teeth. In size these teeth are rather smaller than most of the examples figured by Prof. Owen in the Phil. Trans. of 1872, but the teeth shown in figure 6, plate XL., of that volume have the same dimensions as the *Balladonia* specimens, which, therefore, may be regarded as belonging to an animal of the same species. In life it must have equalled a tapir or donkey in size.

The discovery of these remains considerably extends the known area of distribution of *P. gigas*, for the animal has not previously been recorded from Western Australia. Possibly the collection of further specimens may enable a final decision to be arrived at in reference to the relationship of *Phascolonus* and *Sceparnodon*.

<sup>1</sup> Owen, Phil. Trans. Royal Soc., CLXII., p. 251, footnote p. 257, 1872; also Lydekker Cat. Foss. Mamm. Brit. Mus., part V., pp. 157-160, 1887; raised to generic rank.

*Phascolomys*, Geoff. (1803).<sup>1</sup>*Phascolomys latifrons*, Owen (1845).<sup>2</sup>

<i>Phascolomys lasiorhinus</i> , Gould	..	Mamm. Austr. pls. LIX., LX., 1863
<i>Lasiorhinus m'coyi</i> , Gray	.. ..	Ann. Mag. Nat. Hist. (3) XI., p. 458, 1863
<i>Phascolomys niger</i> , Krefft	.. ..	Mamm. Austr., text to plate v., 1871
.. <i>lasiorhinus</i> var. <i>niger</i> , Krefft		Proc. Zool. Soc., p. 796, 1872

## THE HAIRY-NOSED WOMBAT.

A number of Wombat teeth have been identified as belonging to an animal of this species. They mostly showed the working surface, the outline of which, together with the extent of the external enamel and the nature of the longitudinal grooving, render the determination a matter of comparative certainty.

Several fragments of bone, including portions of the humerus, ulna, radius, and tibia, are undoubtedly phascolomine, and when compared with Prof. Owen's figures in "Extinct Mammals of Australia," plate xcix., etc., they are seen to approach more nearly to the latifrons type than to the more slender *P. mitchelli*. The *P. hacketti* from the Mammoth Cave is larger in size, with teeth which are narrower in comparison to their length, antero-posteriorly, and without the faint longitudinal grooving.

*Phascolomys parvus*, Owen (1872).<sup>3</sup>

## THE DWARF WOMBAT.

Four very worn molar teeth much smaller than those of adult *P. mitchelli* or *P. latifrons* were found amongst the second donation of specimens. They were at first taken to belong to a young *P. mitchelli* but there seems no doubt that they should be attributed to an example of the species, *P. parvus* of Owen figured in plate xix., figs. 6 and 7, and xx., figs. 6, 7 and 8 of the Philosophical Transactions, 1872, of which the founder of the species says on p. 193, "with

<sup>1</sup> *Vide ante*, p. 15, for synonymy.<sup>2</sup> Owen, Proc. Zool. Soc. for 1845, p. 82, 1845.<sup>3</sup> Owen Phil Trans. Royal Soc. 1872, p. 193.



present evidence of the constancy of size, of the molar series of teeth in existing and extinct species of wombat, such series fully in place and well worn, having a longitudinal extent of 1 inch 5 lines (36mm.) cannot be referred to a species with a longitudinal extent of molars never less than 1 inch 9 lines (44.5mm.) and usually more; as *e.g.* in the Tasmanian Wombat, which is the smallest of the known existing species.<sup>1</sup>

The four small molars of this collection when placed side by side measure 30mm. which, making allowance for the missing premolar, practically coincides with Prof. Owen's measurement of 1 inch 5 lines for the whole cheek series.

Diligent search among the material in this collection has failed to reveal the presence of any premolar teeth that might be referred to this species and none of the many fragmentary phascolomine bones identified show sufficient variation from the latifront type to warrant their inclusion under another species.

This animal which has previously been recorded from New South Wales and Queensland must have had a range extending over the whole of the Continent. It is new to this State.

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SUB-FAM. : THYLACOLEONTINÆ.

*Thylacoleo*, Owen (1849-1852).<sup>2</sup>

*Thylacoleo*, Sp.

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## THE MARSUPIAL LION.

(PLATES VII., VIII., FIGS. 1-7).

From the time that the first recognised remains of animals of this genus were described in the Philosophical Transactions of the Royal Society for 1859, there has been a great amount of discussion as to the nature of the food of this gigantic relation of the Phalangers.

Prof. Owen stoutly asserted that the animal was a carnivore, pointing out the great resemblance between its sectorial cheek

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<sup>1</sup> The *P. ursinus* Coll. Journey of the Fly, J. B. Jukes, has a tooth series 47mm. in length, equal to 1 inch 10 lines.

<sup>2</sup> Owen, in Gervais's Zool. et Pal., Franc., 1st edition, Part 1, p. 192, 1849-52.

teeth and the highly-developed premolars of the Lion and other carnivora. Some authorities of repute, such as Falconer, Flower, Huxley, Krefft, and Boyd Dawkins, were of opinion that the animal was a vegetable feeder, "being not much more carnivorous than the Phalangers of to-day," and after years of discussion a compromise was suggested in the words of Lydekker<sup>1</sup>: "Fuller acquaintance with the anatomy revealed, however, its intimate kinship with the Phalangers, and when it was fully realised it was argued that *Thylacoleo* must be a purely vegetable eater. Many of the Cuscuses are, however, partly carnivorous in their habits, and in our own opinion it seems probable that in this respect their gigantic extinct cousin resembled them to a certain extent."

In Australia C. W. De Vis, late of the Queensland Museum, and the late G. Krefft, of the Australian Museum, actively championed the two theories; the former was greatly in favour of the "carnivore" theory, bringing forward as proof bones showing what were believed to be marks of the teeth of *Thylacoleo*; the latter authority was, it seems, the original propounder of the theory which found the more general acceptance in spite of Owen and his followers.

In support of his assertions, Owen declared that the highly-developed incisors had assumed the functions of the canines—a very unusual feature, which, however, in the opinion of the writer, is more easily explained than the presence of highly specialised premolars and degenerate molars in the cheek series of a vegetable-feeding animal, where the molar teeth are usually of such great importance in the task of crushing and pounding food.

For a predatory animal, the well-developed canine teeth, separated by the incisor series, form an ideal mode of seizing, retaining, and killing prey; a double grip is thus obtained, which is much more satisfactory than any hold that could be secured with the help of well-developed median incisors, such as those of the rodents and of *Thylacoleo*.

This was a strong point brought forward in the arguments of Krefft and his supporters, for the examples of carnivorous rodents—

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<sup>1</sup> Lydekker, Lloyd's Natural History, Handbook to the Marsupialia and Monotremata, p. 260, 1896.

the shrews and the insectivorous hedgehog, which is known to kill young rabbits by means of its incisors—are by them regarded as exceptions to the general rule, and not to be compared with *Thylacoleo*, which was said to hunt the *Diprotodon*, *Nototherium*, and Giant Wombat, creatures equalling or surpassing itself in size.

That *Thylacoleo* should be a vegetable feeder seems to be improbable, on account of its diminutive or suppressed molars; these are quite useless for the purpose of pounding and crushing, nor can these functions be performed by the abnormally developed sectorial premolars.

As Prof. McCoy quite rightly observes (Prod. Pal. Vict., Dec. III., p. 8), the opponents of Owen's theory seem to overlook this point when emphasizing the resemblances between *Thylacoleo* and the Rat Kangaroos, which have four, or occasionally three, well-developed molars behind each large premolar.

Again, we have now abundant evidence pointing to the fact that *Thylacoleo* was in the habit of crushing the bones of animals which were its contemporaries. De Vis,<sup>1</sup> Anderson,<sup>2</sup> and Baldwin Spencer and Walcott<sup>3</sup> have described bones which bear undoubted impressions of the upper and lower premolars of the animal. Crushed and broken bones, many bearing tooth-marks, are so plentiful in certain localities that it is quite out of the question to consider them the result of playful antics of the young of *Thylacoleo*; they must rather be regarded as the refuse after a meal partaken of by this Marsupial Lion. In the writer's opinion the animal obtained its food, not after the manner of the lion, tiger and dingo, but rather after the fashion adopted by the hyæna, acting as a scavenger and feeding upon the dead and dying. This would explain the presence of its tooth marks on bones found in the

<sup>1</sup> De Vis, C. W., "On Tooth-marked Bones of Extinct Marsupials," Proc. Lin. Soc., N.S.W., Vol. VIII., 1883/4, p. 187.

"On a Femur, probably of *Thylacoleo*," Proc. Roy. Soc. Q'land, Vol. III., 1886, p. 122.

"Remarks on a Fossil Implement and Bones of an Extinct Kangaroo," Proc. Roy. Soc. Vict., Vol. XII., 1889, p. 81.

"Bones and Diet of *Thylacoleo*," Annals Q'land Museum, No. 5, 1900, p. 7.

<sup>2</sup> Anderson, W. "On Post-tertiary Ossiferous Clays near Myall Creek, Bingera," Rec. Geol. Surv., N.S.W., Vol. I., 1889/90, p. 116.

<sup>3</sup> Baldwin Spencer, Dr. W., and Walcott, R. H., "The Origin of Cut on Bones of Australian Extinct Marsupials," Proc. Roy. Soc. Vict., Vol. XXIV., Pt. 1, 1911, p. 92.

lakes and soaks, and if we regard it also as in the habit of forming its lair in caves, and dragging thither the more or less mutilated bodies of its victims, we could understand the discovery of gnawed bones and bone-bearing coprolites in cave breccias as recorded from Queensland and New South Wales.

Geological Surveyor Anderson<sup>1</sup> described the tooth-marked bones in the following terms: "Occurring in the ossiferous portions of the clays were numerous small fragments of bones, generally a few inches in length, and chiefly pieces of the longer limb bones, which had been broken into fragments prior to their deposition in the clays. In almost every case the sharp fractured edges and angles of these fragments had been slightly rounded by attrition, but they were by no means so well water-worn as the pebbles which occurred along with them. The fragments of the thicker bones rarely showed an entire transverse section of the bone, which had not only been fractured transversely, but also longitudinally. In the case of fragments of the thinner bones, the transverse section is generally complete, the bone not having been fractured longitudinally. The large majority of the broken fragments show unmistakably the teeth-marks of some carnivorous animal, or animals. Most of these marks are, however, too fine to have been produced by the carnassial teeth of *Thylacoleo*, although there are some of them which seem large enough and coarse enough to have been so produced. The fragments of bones which show evidences of having been gnawed, are chiefly pieces of the shafts of the longer limb-bones and ribs. The teeth-marks occur singly along the surface of the fragments, corresponding marks being often present on the opposite surface, indicating the action of the teeth of both jaws on the bones. Generally, however, the marks are confined to one or both ends of the fragments, which often bears evidence of having been bitten sharp off, while close to the sharply bitten end the surface is furrowed with teeth-marks, showing that whatever the animal was, by the action of whose teeth the marks were produced, it had a similar habit to that of a dog, and other carnivora possess, of holding one end of the bone on the ground between the forepaws while it gnawed the opposite free end."

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<sup>1</sup> Loc. cit., p. 122.

The specimens identified as belonging to *Thylacoleo* are not numerous, they include however, the large upper and lower incisors, the third upper incisor, formerly regarded by Prof. Owen as the canine, the characteristic upper and lower PM<sub>4</sub> and a fragment of the maxilla and malar bearing in situ a perfect left upper premolar (PM<sub>4</sub>) with the adjacent first molar, both these teeth are very much worn and evidently belong to a fully developed animal.

In addition to these there is a small fragment of the left lower jaw with sockets of the last molar and a portion of the anterior border of the coronoid.

These teeth and fragments, in showing signs of much wear, all suggest that the aged animal (or animals) to which they belonged was from 1-4th to 1-5th smaller than the animals described and figured by Prof. Owen and Prof. McCoy.

The first upper incisors, plate VII., figs. 1 and 2, are mostly fragmentary; they show that the perfect tooth is curved and compressed, and the enamelled area practically confined to the anterior and exterior surfaces, as in the wombat and the Rodentia. The greatest vertical extent is at the antero-exterior angle of the tooth. On the inner side there is a wedged shaped border confined to the anterior margin, and with its base at the cutting edge. On the posterior aspect the condition was originally similar, but continuous wear has removed much of the enamel which is now almost entirely confined to the cutting edge, a groove in the dentine, presumably caused by the friction of the lower incisor is most distinct.

The distribution of the enamel is entirely different on the canine teeth of the Carnivora, which are completely covered on their exposed surfaces and therefore much more powerful than these incisors.

The third upper incisor in the collection closely resembles the tooth figured by Prof. Owen in Phil. Trans., 1871, Plate XI., fig. 11, which Krefft states is the third incisor<sup>1</sup>, but which according to plate XII., figs. 15-18, accompanying his article, should be one of the premolars<sup>2</sup>. This latter designation is evidently an error, for

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<sup>1</sup> Krefft. Ann. and Mag. Nat. Hist., Series 4, Vol. X., 1872, p. 172.

<sup>2</sup> Loc. cit., p. 182.

Kreffit states<sup>1</sup> with reference to Prof. Owen's determinations "though he figures the small tubercular premolars with the nail headed crowns right enough."

The large upper premolars (Plate vi., fig. 3) has the typical outline; it is slightly grooved vertically on the outside as well as the inside, the ridges becoming somewhat inflated towards the base. The enamel is worn down obliquely, particularly at the posterior region where the dentine is exposed; the worn surface is on the inner side of the tooth.

As is usually the case in *Thylacoleo*, the small, obliquely denuded first molar is situated on the inner side of the posterior extremity of the premolar. It has suffered much more than this latter, being worn down to the root on its inner surface; the tooth is clearly the last of the upper cheek series.

The first teeth in the mandibular series are the incisors; of these, one, the right of a fairly young animal (plate viii., fig. 4), and another, the left of an older individual (plate viii., fig. 5, 6 and 7), are fairly perfect. Like all the other teeth from Balladonia, they are smaller than those figured by Prof. Owen. The right incisor has its posterior surface rather more curved than Prof. Owen's figures; it has the same number of serrated strengthening ridges, but the point of the tooth is considerably worn, so that an oblique, roughly circular patch of dentine about 4mm. in diameter is exposed. It is unlikely that the origin of this worn tip was a fracture.

Kreffit in his paper states<sup>2</sup>: "In drawing a few of the lower incisors of *Thylacoleo* . . . I noticed, to my astonishment, clear evidence of attrition on the inner side of several. There was no doubt about it, they had touched each other during the lifetime of the animal (as kangaroo teeth do), but generally at the tips only. In one specimen, however, the surface of the inner side was observed to be quite smooth to the extent of one inch on the lower margin. The ridge so prominent in young or immature specimens has totally disappeared, and my supposition that the jaws were loosely attached is clearly borne out." No other authority appears to have referred to this feature.

<sup>1</sup> Loc. cit., p. 172.

<sup>2</sup> Kreffit. Ann. and Mag. Nat. Hist., Series 4, Vol. X., 1872, p. 181.

The *Balladonia* specimens both show this polished surface; in the younger tooth it has only just commenced, but on the inner surface of the other, one of the serrated ridges has quite disappeared—the action seems to commence at the point of the tooth and extend along the anterior edge, and then backwards towards the posterior border. The irregular area of the worn and polished surface is shown at *b* in figs. 4 and 6 of plate VIII.

The presence of these polished surfaces on the incisors of carnivorous or ossivorous animals is, I believe, unique. A carnivore would not require its lower median incisors to work against one another in a scissor-like manner, as do those of the phytivorous Kangaroo, and if traces of attrition are present an explanation must be sought in another direction. On examining the mandibles of the *Dasyuridae*, among the marsupials, and of the *Canidae*, which may be considered their Placental equivalents, it will be found that the two halves of the lower jaw are but loosely connected for a longer or shorter period of the animal's existence. A number of these mandibles in the Museum Collection were carefully inspected, but no marks of attrition could be seen on the inner sides of the first incisors. It was, however, noted in these animals that during the process of crushing the food the upper cheek teeth are directly and alternately above the lower ones, hence any movement of the mandible due to the force used in crushing or masticating food would be outwards, that is to say, the two median incisors would be forced apart.

In *Thylacoleo*, as restored by Prof. Owen, on the other hand, the relative positions of the large functional upper and lower premolars are such that the upper teeth pass outside the lower ones. The crushing of food between the cheek teeth would therefore tend to press the lower mandibles together, and cause the incisors to rub against one another. In this way, flat surfaces might be worn on the inner sides of the two median incisors.

It is to be hoped that more abundant remains of this animal will be found in the near future, for, could an almost perfect skeleton be examined, many points which are at present difficult to interpret would be made clear.

At various dates, odd skeletal bones have been determined as probably belonging to *Thylacoleo*, and suggestions made concerning

the outline of the perfect animal. According to one of these, the Marsupial Lion, unlike the other Phalangers, would have progressed after the manner of Kangaroos and Wallabies, and not on all fours as Prof. Owen had determined. Our knowledge of the animal, its food and habits is very incomplete, and theories concerning its life-history must at present be partly conjectural, but the discovery of a more perfect skeleton would soon definitely determine the nature of the creature's food.

The other lower incisor, besides possessing the obliquely truncated tip and the worn surface on the inner aspect, shows distinct signs of attrition on its posterior face. For a distance of 12.6mm. near the outer edge a lenticular mass of enamel has been removed and a distinct hollow worn in the underlying dentine. Judging from the British Museum (Nat. Hist.) Cast M1958, this area ultimately becomes connected with the gradually increasing patch of dentine exposed at the worn tip.

Of the lower functional premolars there is a fragment comprising the anterior half of the enamelled crown, showing but little wear. Of the left mandibular P<sub>4</sub>, one tooth, still inserted in a fragment of the mandible, is almost perfect, the enamel coating of the antero-internal angle alone being absent; the two other fragments are the anterior and posterior halves of the enamelled crowns; both showing longitudinal strips of dentine where the enamel has been removed by attrition.

As was the case with the other teeth described, these worn premolars are less than the corresponding teeth figured by Prof. Owen; in this instance, the *Balladonia* teeth are from .72 to .8 the size of those from the Eastern States.

The discovery of more abundant remains in a better state of preservation will, no doubt, show that the Western Australian Marsupial Lion was distinct from the Eastern species, *Thylacoleo carnifex* (Owen) of Victoria, and *Thylacoleo oweni* (McCoy)<sup>1</sup> of Queensland and New South Wales.

Remains of *Thylacoleo* have not previously been recorded from Western Australia.

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<sup>1</sup> McCoy. Prod. Pal. Vict., Dec., III., p. 9, 1876.



Fam. MACROPODIDÆ.

Sub-Fam. MACROPODINÆ.

*Macropus*, Shaw (1790).<sup>1</sup>*Macropus magister*, De Vis (1895).<sup>2</sup>

*Macropus titan*, Owen (*in parte*) .. Owen. Phil. Trans., 1874, p. 248, *et seq.*,  
plate xxii., figs. 17, 18.  
Lydekker Cat. Foss. Mamm. Brit. Mus.,  
Part V., p. 225, 1887.  
Lydekker Handbook Marsup. p. 254, 1896.

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## MACROPUS MAGISTER.

At the time of founding this new species, De Vis went fully into the points of resemblance and difference of *M. titan* (Owen) and this form of extinct Kangaroo. The specimen from Balladonia consists of a fragment of the left lower jaw containing one perfect molar, presumably M<sub>2</sub>, and the stumps of the two anterior teeth; the perfect tooth cannot be distinguished from the teeth M<sub>2</sub> shown in figures 13 and 14, plate xxii., and figure 10, plate xxvi. of Phil. Trans., 1874, nor does it differ from several of the second molars of *M. magister* from Queensland, presented to this Museum by Mr. C. W. De Vis some thirteen years ago. The dimensions of the crown are 14.4 and 8.4; the crest of the hind lobe is somewhat worn, so that the tooth must have been in use for some time. The anterior talon has straight converging sides and a slightly sinuous, almost straight, anterior edge; the lobes are thick, with rounded angles and rounded crests, having their convexity backwards; the connecting links or bridges are slightly curved, the exterior face being concave. A vertical fold and a groove are present on the posterior aspect of the tooth. There is a bulging of the base and to erect plate.

This is the first recorded specimen of this Queensland form for Western Australia. The fact that an undoubted *M. titan* was obtained in the Mammoth Cave in 1909 is of importance when considering the distribution of the two kindred species.

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<sup>1</sup> Nat. Misc., i. text to plate xxxiii., 1890.

<sup>2</sup> Proc. Linn. Soc. N. S. Wales, 2nd Series, Vol. X., p. 120, 1895.

*Macropus anak*, Owen (1859).<sup>1</sup>

<i>Protomnodon anak</i> , Owen (in parte) ..	Phil. Trans., 1874, p. 275.
„ <i>og</i> , Owen ..	l.c. 1874, p. 277.
„ <i>roechus</i> , Owen ..	l.c. 1874, p. 281.
„ <i>mimas</i> , Owen ..	l.c. 1874, p. 278.
„ <i>anlaeus</i> , Owen ..	Ext. Mamm. Aust., p. 448, 1877.
<i>Sthenurus brehus</i> , Owen ..	Phil. Trans., 1874, p. 272.
„ <i>atlas</i> , Owen (in parte) ..	l.c. 1874, p. 265.
<i>Micropus mimas</i> , Owen sp. ..	Flower, Cat. Vert. Anim. Mus. Royal Coll. Surg., Part II., p. 720, 1884.
„ <i>brehus</i> , Owen sp. ..	Lydekker, Cat. Foss. Mamm. Brit. Mus. (N.H.), Part V., p. 207, 1887.
„ <i>roechus</i> , Owen sp. ..	Lydekker, Cat. Foss. Mamm. Brit. Mus. (N.H.), Part V., p. 212, 1887.
„ <i>anak</i> , Owen sp. ..	Lydekker, l.c., p. 214
<i>Halmaturus anak</i> , Owen sp. ..	Troussart, Cat. Mamm. Tom. II, p. 1181, 1898-9.

## MACROPUS ANAK.

Two fragmentary mandibles are conspicuous by the size of the teeth they bear and the limited depth of the horizontal ramus. The portion of the left jaw contains two molars (M<sub>2</sub> and M<sub>3</sub> in situ.) These teeth are almost perfect; they are but little worn, and therefore show the very faint verticle folds on the anterior aspects of the lobes. The other specimen—a part of the right ramus—shows the last molar rising from its alveolus, and the preceding one up in position; this exhibits signs of wear on the posterior lobe, but the very faint vertical folds or grooves are still visible.

The teeth are much larger than those of *Sthenurus*, and can readily be distinguished from the molars of the living species of *Macropus*; they differ somewhat from all Owen's figures of teeth of the species included in the above synonym, being very broad in comparison with their length.

A specimen of *Macropus anak* (c. 112, Q.M. 10731) in the Museum Collection, presented by Mr. C. W. De Vis of the Queensland Museum some 13 years ago, very closely resembles the *Balladonia* fossils. Upon referring to a paper by this authority,<sup>2</sup> "A Review of the Fossil Species of the Macropodidæ in the Queensland Museum," this species is defined, as follows: "Molars smooth,

<sup>1</sup> Proc. Geol. Soc., XV., p. 185 (part), 1859.

<sup>2</sup> Proc. Linn. Soc. N. S. Wales, 2nd Series, Vol. X., p. 75, 1895.

with rectilinear crests, feeble lines and sharp angles, upper molars without distinct anterior links, lower seldom without posterior talons. . . . These posterior basal talons are generally present as erect plates, raised rims, or a mere but decided bulging of the base."

This description applies to the specimens under consideration, and is made to embrace a number of Owen's species, as De Vis found, after examining 330 specimens, that there was a good deal of variation, and that intervening forms made the gradations so minute that it was quite impossible to draw any hard and fast line of separation. He states<sup>1</sup>: "The degree of variation in the length of the cheek teeth found in this species is less than that shown by *Halmaturus ruficollis*, and the premolar has a more restricted range of length than in most of the larger existing Wallabies. On the other hand, the width of the teeth and the depth of the mandible have a somewhat greater range of measurement than in living species, and in thickness the ramus is decidedly more variable; but, as in all the dimensions, the extremes are reached by insensible gradations, excess even in the width of the teeth must be considered a peculiarity of the species. . . . It is quite the most abundant macropod of its period."

The specimens from Balladonia resemble the mandible figured by Owen in Phil. Trans., 1874 (plate xxv., figures 7 and 8), as *M. anak*, and as regards the teeth they most nearly approach those of *P. mimas* of plate xxvi., figures 1, 2 and 3, which they slightly exceed in width.

The teeth of *P. mimas* (plate xxiv., figs. 13 and 14, and plate xxvi., figs. 4, 5 and 6), the *P. roechus* (plate xxvii., figs. 10, 11 and 12), and the *P. antaeus*, figured on plate cx. of "Extinct Mammals of Australia," all show points of resemblance to the teeth from Balladonia, but differ in the relatively less width of the crowns.

Remains of this species have been obtained in all the Eastern States and South Australia, but are now recorded for the first time from deposits in Western Australia.

It was probably one of the largest Kangaroos, rivalling the huge *M. titan*, but giving pride of place to its contemporaries, the genera *Procoptodon* and *Palorchestes* which have likewise become extinct.

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<sup>1</sup> Loc. cit., p. 106.

*Sthenurus*, Owen (1873).<sup>1</sup>

*Sthenurus atlas*, Owen (1838).<sup>2</sup>

*Macropus atlas*, Owen .. .. Mitchell's "Three Expeditions into the Interior of Eastern Australia," 2nd Ed., Vol. II., p. 359, 1838.

*Protemnodon anak*, Owen (in parte) .. Phil. Trans., 1874, p. 275.

## STHENURUS ATLAS.

There are several specimens which have been identified as belonging to this species.

A small fragment consisting of the anterior portion of the left ramus with the root of the incisor, the diastema, and the permanent premolar rising from its alveolus, has this important tooth in perfect condition. The tooth closely resembles the rising premolar figured by Prof. Owen on Plate xxii. (figs. 5 and 6) in the Philosophical Transactions of 1874, but has a somewhat different tooth sculpture, suggesting that this feature is subject to a certain amount of variation (see also Owen's various figures of this premolar). The size of the diastema, the dimensions of the mandible, and the position of the predental foramen agree exactly with Owen's drawings.

The differences between the lower permanent premolar of this species and the corresponding tooth of *S. occidentalis* have been fully discussed,<sup>3</sup> but are more readily discernible when specimens of the two species are placed side by side.

Another example (in three fragments) comprises the major portion of the right horizontal ramus, with the base of the coronoid, the extent of the cheek teeth, part of the diastema, and the perfect incisor. The first and second molars, both much worn, are the only perfect cheek teeth present. The longitudinal links have disappeared, and the crown of the tooth is practically reduced to a flat grinding surface; there is no trace of any verticle grooving or folding. A portion of the outer surface of the permanent premolar is preserved, the other teeth are represented by roots only. The

<sup>1</sup> For synonymy of the genus, *vide ante*, p. 31.

<sup>2</sup> In Mitchell's "Three Expeditions," 2nd Ed., p. 359, 1838.

<sup>3</sup> *Vide ante*, pp. 32, 33 and 34.

incisor which has lost the tip of its root is very much worn, more than half the enamel on the inner side having been removed. The ower portion of the enamelled surface on this face is worn and polished by the friction of the other incisor, showing that the symphysis was lax and that, by a motion of the jaws, the two incisors worked against one another in a scissor-like manner.

The jaw differs from *S. occidentalis* in its general outline, the contour of its inner and outer surfaces, the greater extent of the cheek teeth (P<sub>4</sub> M<sub>4</sub>), which is 70mm. against 62mm. in the other species, and by the greater dimensions, both longitudinal and transverse, of all the individual teeth. On the other hand, this Balladonia animal has many points in common with the one whose broken mandible is figured by Owen (loc. cit., plate xxii., fig. 9, and plate xxiv, figs. 7 and 8). The extent of the tooth series and of P<sub>4</sub>-M<sub>2</sub>, the contour of the bone and the dimensions of the individual teeth are identical.

The length of the tooth series and the measurements of the mandible do not come within the limits given by De Vis<sup>1</sup> in his description of the species, but, as the specimen figured by Owen has not been excluded by this authority when he restricted the species, and has been allowed to stand by Lydekker<sup>2</sup> in his catalogue, this jaw may be regarded as a true *S. atlas*.

A third specimen, consisting of the greater part of the horizontal jaw with roots of the four molars, may be included; it has an outline similar to the preceding, but has its lower margin perfect.

This animal is new to the State. Its home has, up to the present, been considered to be in Queensland and New South Wales. The finds at Balladonia have greatly extended its range.

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<sup>1</sup> Proc. Linn. Soc., N. S. Wales, 2nd Series, Vol. X., p. 98, 1895.

<sup>2</sup> Loc. cit., p. 233.

DETERMINATION OF THE EXACT LOCALITIES  
WHERE CAMBRIAN FOSSILS WERE COLLECTED  
BY E. T. HARDMAN IN 1884.

By LUDWIG GLAUERT, F.G.S.

In 1884, the late Mr. E. T. Hardman, F.G.S., visited the valley of the Ord River in the Kimberley district, where he collected a number of specimens which, together with many others obtained during that and the previous expedition into the Kimberleys, were mostly deposited in the Geological Museum, Fremantle, and the Swan River Mechanics' Institute, Perth.

The pieces of limestone which were consequently found to contain Cambrian fossils were placed in the hands of Mr. R. Etheridge, Curator of the Australian Museum, Sydney, for examination. His manuscript notes, afterwards handed to Mr. A. H. Foord for incorporation in his "Description of Fossils from the Kimberley District, Western Australia,"<sup>1</sup> first demonstrate the presence of Cambrian beds in this State. The fossils described are the Pteropod *Salterella hardmani* and the Trilobite *Olenellus* (?) *forresti*.

The localities given with the published descriptions are "Kimberley District" for the former, and "River south of Base Line, Kimberley District" for the latter. These, it must be admitted, are very vague.

Numerous attempts have been made to discover the spot where the specimens were collected but without avail.

Mr. R. Etheridge stated in 1906<sup>2</sup> that Mr. Hardman's "specimens were very poorly localised, and I have quite failed to identify his precise locality."

Dr. R. Logan Jack had an opportunity of traversing a great deal of the country surveyed by Hardman, but he, too, was

<sup>1</sup> Geol. Mag. Dec. III., Vol. VII., p. 98, *et. seq.*

<sup>2</sup> Northern Territory of South Australia; N.-W. District Reports (Geological and General) resulting from the Explorations made by the Government Geologist and Staff during 1905; General Geology, p. 42, 1906.

constrained to admit that he had failed to trace the Cambrian limestone beds from which the *Salterella* and the *Olenellus* were collected. In fact, he considered the task so hopeless that he remarked in 1906<sup>1</sup>: "The palæontological evidence is also exceedingly meagre and, scientifically speaking, ought to be ignored, as the two localities from which Hardman collected Cambrian fossils . . . have been defined too vaguely for identification as Kimberley District and River south of Base Line."

In his presidential address to Section C (Geology) at the Adelaide Meeting of the Australian Association for the Advancement of Science in 1907, Mr. A. Gibb Maitland gives as his opinion<sup>2</sup>: "Despite the fact of poor localisation of Hardman's fossils, it may, I think, be taken for granted that Cambrian beds do occur somewhere in Kimberley about South latitude 18°. The recent discovery of *Olenellus* and *Salterella* in the limestones of the Daly River in the Northern Territory by Messrs. Brown and Basedow is of considerable geological importance, indicating a somewhat wide distribution of Cambrian strata in Northern Australia, and makes the solution of the Hardman puzzle almost imperative."

Mr. H. W. B. Talbot visited the Elvire and Ord rivers in his traverse of the route followed by the Canning Survey Party, 1907-1909.<sup>3</sup> In the course of his journey from Flora Valley Station to Wyndham he collected several pieces of fossiliferous limestone from the Ord River Station. I had the good fortune to handle these specimens for a few moments, and as far as I could judge, the fossils consisted of *Salterella hardmani* in a hard sub-crystalline limestone of a greyish colour.

These specimens are now in the hands of Mr. R. Etheridge of Sydney, and when his report is available I have no doubt that my determination of the age of the rock and the nature of its fossil contents will be confirmed.

The subject first came under my notice when preparing the "List of Western Australian Fossils," which was offered to the Government Geologist and published by him in Bulletin 36 (III).

<sup>1</sup> "The Prospects of obtaining Artesian Water in the Kimberley District." G. S. W. A. Bulletin, No. 25, p. 15, 1906.

<sup>2</sup> Reo. Austr. Assoc. Adv. Soc., Adelaide Meeting, 1907, p. 140, 1908.

<sup>3</sup> G. Survey (W.A.) Bulletin, No. 39, Perth, 1910.

Palæontological Contributions to the Geology of Western Australia, 1910). Some of the notes then made were recently discovered among other papers, and I decided to investigate matters more thoroughly as I now had the necessary leisure.

It was found that, whereas the locality mentioned in the description of *Salterella hardmani* was correct, the record on the label attached to the *Olenellus* had been inaccurately copied. In a list of Western Australian Fossils in the Collection of the British Museum (Nat. Hist.) obtained for my assistance by the Acting Government Geologist, Mr. H. P. Woodward, F.G.S., in 1908, the locality for the Trilobite is given as "River south of Base Line Camp" and "Ord River"—that is to say, the Trilobite remains were collected in *two* localities, a fact confirmed by the following paragraph in Mr. Etheridge's description.<sup>1</sup> "On the weathered surface of a similar limestone rock, and from the same locality as the head just described, there is a short spine probably belonging to the present species; if so, it would be the telson. In another piece of limestone, similar to those containing the head and telson, there is a portion of a thoracic segment which agrees in form with the first two segments of an *Olenellus*; this may also belong to the present species."

The addition of the single word "Camp" simplifies the localisation of the Cambrian beds from which the fossils were obtained.

As the specimens collected in 1883 and 1884 and deposited in the Geological Museum at Fremantle are tabulated in the form of an appendix to Hardman's 1884 Report, published in 1885, a search was made, with the result that an entry, "Hb 27. Limestone with lead, zinc, and fossils, from river south of Base Line Camp; several specimens,<sup>2</sup>" was discovered.

No "Base Line Camp" is referred to in the Report for 1883, but in that for the succeeding year, paragraphs 295<sup>3</sup> to 299 describe "Section between J 34 and the *Base Line Camp*," and in paragraph 298 we read "Base Line Camp, Z 27," which an examination of Hardman's map shows was placed on the left (north) side of the

<sup>1</sup> Geol. Mag. Dec., III., Vol. VII., p. 99, 1890.

<sup>2</sup> Report on the Geology of the Kimberley District, Western Australia; Perth, 1885, p. 36.

<sup>3</sup> Loc. cit., p. 32.



river, *north* of the Base Line W.B.-E.B.<sup>1</sup> This would account for the omission of the name of the river, for Hardman would, no doubt, consider this localisation sufficiently distinctive.

In paragraph 302 of this Report, Hardman writes, "Base Line Camp to Hardman Range. On this side of the river the prevailing rock is limestone, which crops out from under the alluvium and soil in low ridges, bearing a little N. of E. In the present section, only one of the ridges is visible. It is about half a mile wide, and has been traced for 10 or 12 miles in a direction to E.-N.E., about two miles from the river and parallel to it."

It may be that these limestone beds do not outcrop in the bed of the river close to Camp Z 27, for the only rocks mentioned in paragraph 298 as having been observed in the river bed between the Base Line Camp and J 34 are "a few beds of red shales and micaceous mudstones." The limestone may extend north of the patch mapped by Hardman, but it must be admitted that some of Hardman's localisations are not very precise. As an example of this it may be mentioned that in paragraph 322 he states: "Lead, zinc, etc., have been noticed in the form of Galena in the limestone rocks *a little south of the Base Line* (Ord River)," whereas in the Appendix we read that specimens "Hb 27. Limestone with lead, zinc, and fossils" came from "*River south of Base Line Camp.*" Therefore, as these minerals and fossils were collected either in the (Elvire) *river* south of Base Line Camp or (Limestone) *ridge* south of the Base Line (see specimen HB 18) it may, I think, be concluded that the Hardman Trilobite also came from one of these two localities, presumably from the former.

As stated above, one of the *Olenellus* fragments was obtained from a locality some distance away from the Base Line Camp specimens. This is taken to be the one referred to as "Ord River" in the British Museum List of 1908, and is doubtlessly specimen HB 48 of Hardman's Appendix, localised as "River bed Ord, near J 38"<sup>2</sup> In paragraph 304 Hardman writes: "About five miles below the junction of the Elvire and the Ord, limestone crops out in the river bed, and in low ridges through the alluvium to the

<sup>1</sup> In Mr. Maitland's Presidential Address this line is incorrectly referred to as W.B.-E.F.; loc. cit., p. 141.

<sup>2</sup> Loc. cit., p. 37.

south, their general trend being E.N.E." The position of these exposures is opposite J 38.

The only other catalogued fossiliferous limestone from the river bed is " $\frac{HB\ 2}{32}$  limestone with fish palate, Camp Z 31, river bed Ord," which obviously is not the specimen named by Mr. Etheridge.

The specimen of *Salterella hardmani* in the Museum Collection is labelled HB 33, and was obtained from Mt. Panton.

Hardman's palæontological observations in the field do not in any way lead to the belief that his locality south of Base Line or Base Line Camp refers to the Base Line laid down in 1883. Firstly, his list of specimens collected in 1883, in the Appendix of his Report for 1884, does not include a single fossil or fossiliferous specimen collected from or near Mt. Campbell, where the Base Line was situated<sup>1</sup>; and, secondly, the fossils observed in the rocks near that locality show a purely Carboniferous facies, for they include *Poteriocrinus*, *Athyris*, and *Lithodendron*<sup>2</sup> in a good state of preservation.

In the Report for 1884, numerous fossils are recorded from the Ord river district, including some purely Carboniferous genera, but there is some likelihood of Hardman's field observations being at fault, for, unlike the fossils from the Western district, these latter were "usually so worn by the excessive action of the weather in this tropical climate that identification as to species is almost impossible in many cases."<sup>3</sup> Of the genera mentioned, only one, *Athyris*, is more or less confined to the Carboniferous.

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#### LITHOLOGICAL EVIDENCE.

In describing the Limestone Series (L) of the Ord District, Hardman says<sup>4</sup>:—

"123. This portion of the limestone country rises in a succession of low and almost imperceptible terraces into high tablelands. One of these extends to the east of the Ord, near the 'Cattle Station,' and another to the north and east of the Negri River, where it is capped by Mt. Panton.

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<sup>1</sup> Mr. Gibb Maitland's Presidential Address, loc. cit., p. 141.

<sup>2</sup> Hardman's 1883 Report (Perth, 1884), p. 16.

<sup>3</sup> Hardman's 1884 Report (Perth, 1885), p. 17.

<sup>4</sup> Loc. cit., p. 17.

"124. The Ord limestones are for the greater part hard and flaggy, rarely massive, usually grey in colour, sometimes sandy or magnesian, and seldom fossiliferous. In many parts of the district they are interbedded with red shales, marls, and sandstones, the former of which contain occasionally layers of gypsum, together with traces of rock salt. . . .

"125. Over the great part of this country the limestone crops out in bare masses, cut through by numerous gullies and water-courses, along which the rock forms high cliffs and scaurs, showing the stratification—which dips at a very low angle in various directions—very distinctly."

Dr. R. Logan Jack states<sup>1</sup>: "The strata [of the limestone] which at the south-western and south-eastern boundary of the formation dip to the north-east and north-west, are practically horizontal on the Ord River below its junction with the Elvire, and probably continue to be horizontal where they are covered, on the left bank of the Ord."

These descriptions enable us to define the known outcrops of Cambrian limestones of Western Australia as being hard and flaggy, usually grey in colour, either horizontally bedded or dipping at a very low angle in various directions.

Evidence of confirmatory nature is found in the record of the explorations made by the Government Geologist of South Australia and his Staff in 1905. Mr. H. Y. L. Brown reports<sup>2</sup>: "During the present examination of the belt of limestone, extending south-easterly from east of Mt. Litchfield to the Katherine River, was proved to be of Cambrian age by fossil evidence. Outcrops of the rock, two miles north of Noltenius Billabong, and about nine miles from the Daly River, consist primarily of a compact blue-grey and yellow sub-crystalline limestone, parts of which are rich in pteropod tests of *Salterella*, weathering slightly in relief. The beds are horizontal, and the line of outcrop trends north-westerly. No deep section is available, and, wherever encountered, the outcrops rise but a few feet above the surface. The physical features are low, banked, denuded tables, separated by horizontal joint planes, and piled one upon the other, the uppermost being very much smaller

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<sup>1</sup> Loc. cit., p. 26.

<sup>2</sup> Loc. cit., p. 14.

than the lowest visible, which rests upon massive beds of the same rock below.<sup>1</sup> The exposed surfaces have been eroded in a remarkable manner by the atmosphere, and appear in the form of sharp, confluent, serrated ridges, grading downwards on all sides, the whole giving the effect of a model of mountain chains on a small scale. The rock decomposes comparatively readily, and produces a rich red clay soil.<sup>2</sup> The beds overlie unconformably the schistose Pre-Cambrian rocks on the east and west. . . . In lithological characters, this formation is similar to that covering large areas between the Katherine Station and Flora Falls; also to that at Jasper and Timber Creeks, off the Victoria River: between the Elsey and Daly Waters Stations on the Transcontinental Telegraph Line; at Anthony's Lagoon, Brunette Downs, Alexandria Station, and other places. It is most probably continuous beneath the basalt, sandstone, and other later formations. The occurrence of Cambrian fossils near the Daly River and Alexandria Station prove that these widely separated expanses of limestone are identical in age."

### CONCLUSIONS.

Hardman collected his Cambrian fossils :—

At River bed (Elvire) South of Base Line Camp Z27 (HB27).

At river bed (Ord) 5 miles below its junction with the Elvire, opposite the Hill J38 (HB 48).

And at Mt. Panton, Northern Territory (HB33).<sup>3</sup>

Mr. H. W. B. Talbot collected Cambrian fossils (*Salterella*) at the Homestead, Ord river Station.

The stratigraphical results may be summarised as follows :—

Cambrian rocks are exposed in Kimberley along the valleys of the Elvire and Ord rivers from near the North-western extremity of the Hardman Range to the Ord River Station, and so on to Mt. Panton (N.T.),<sup>4</sup> thence they will no doubt be found to

<sup>1</sup> This admirably describes the outcrop in the Ord River Valley, and at Mt. Panton.

<sup>2</sup> A marked feature round the Ord River Station homestead.

<sup>3</sup> The "Limestone with Fish Palate," <sup>HB2</sup><sub>32</sub> is also of Cambrian age (*postea* p. 74).

<sup>4</sup> An outlier of carboniferous age as a capping to Mt. Panton would explain the presence of carboniferous fossils at that locality.

extend to Jasper and Timber Creeks off the Victoria River, where the beds have been recognised by Mr. H. Y. L. Brown. In due course, when the mapping of the beds is extended, it will probably be joined up to the Cambrian Limestone of Flora river, the Katherine river, and the Daly river valley, and the other localities further east and south in the Northern Territory and Central Australia.

The exact localisation of these Cambrian beds will have a profound effect upon the Geological mapping of this State. When the matter has been further worked out it will doubtlessly be found necessary to regard most of the beds marked "S" on the eastern half of Dr. Jack's map of 1906 as of Ordovician age<sup>1</sup>. Beds mapped as "D" would become pre-Cambrian<sup>2</sup> to distinguish them from the still older metamorphics (M) which might be regarded as Archæan<sup>3</sup>.

The Cambrian Limestone beds of Northern Australia, extending from the Elvire river near the north-western extremity of the Hardman Range to the Daly river (Noltenius Billabong) and Alexandria Cattle Station in the Northern Territory are thus seen to present a remarkable uniformity of character throughout the course of their outcrops, and to be almost, if not quite, horizontally bedded wherever they appear at the surface.

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#### NOTE BY THE EDITOR.

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19th March, 1912.

I have just received the following communication from Dr. F. A. Bather, F.R.S., Assistant Keeper of Geology in the British Museum:—

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<sup>1</sup> Mr. Talbot has found similar beds to the south of those just mentioned, they extend from lat. 23deg. S. to 25deg. S., with two smaller patches further south.

<sup>2</sup> Mr. H. W. B. Talbot has shown that beds similar to these, and also horizontally bedded, extend southwards to lat. 23deg. S., long. 124deg. E. (Bulletin No. 39).

<sup>3</sup> A band of these ancient metamorphic rocks was seen by Mr. Talbot to cross his route and extend from Mt. Methwin to Lake Nabberu, a little to the north of Wiluna.

Geological Department,  
British Museum (Natural History),  
Cromwell Road,  
London, S.W.

19th February, 1912.

Memorandum to the Director of the Western Australian  
Museum and Art Gallery, Perth.

The following is an exact copy of all labels, numbers, etc.,  
attached to the specimens of *Olenellus forresti* and *Salterella hardmani*  
collected by Hardman in the Cambrian rocks of Kimberley, and  
preserved in the Geological Department of the British Museum:—

- (I 2346A) *Olenellus* ? *forresti* (Etheridge Jnr. M.S.) Foord  
Cambrian. "River south of Base Line Camp."  
Kimberley, W. Australia.  
Figd. Geol. Mag. 1890, pl. iv., fig. 2a  
Presd. E. T. Hardman, 1886.

R  
S. of  
Base line  
H B 27

- (I 2346) Do. do. do. fig. 2  
Presd. E. T. Hardman, 1886.

River  
S. of  
Base line  
H B 27

- (I 2347) *Olenellus forresti* (Etheridge Jnr. MS.) Foord  
Cambrian. Ord River, Kimberley District,  
W. Australia  
Figd. Geol. Mag. 1890, pl. iv., fig. 2b  
Presd. E. T. Hardman, 1886.

Ord River  
Palæozoic  
H B 2/32

- (G 7428) *Salterella hardmani*.

Spec. fig. in Geol. Mag. 1890,  
pl. iv., ff. 1a-b  
Presented by Gov. W. Australia  
per H. P. Woodward, Esq.

No. 1  
K 5

*Salterella hardmani*  
(Ether.)  
Lr. Palæozoic  
Kimberley  
Exhibitor, E. T. Hardman

## PERMO-CARBONIFEROUS FOSSILS FROM BYRO STATION, MURCHISON DISTRICT.

By L. GLAUERT, F.G.S.

A number of fossils of Permo-Carboniferous age, obtained in the course of sinking a bore at Byro Station, on the Byro plains south of the Carrandilby Range in the Murchison, were presented to the Museum by Mr. L. Landauer of Day Dawn.

The majority of the fossils have the shell preserved, but others appear as more or less glossy internal or external casts; they include *Spirifer convolutus* (Phillips), *S. musakheylensis v. australis* (Foord), *Chonetes pratti* (Davidson), *Dellopecten subquinclineatus* (McCoy), and *Aviculopecten sprengi* (Johnston). Two new forms have been recognised; the *Spirifer* is represented by a number of specimens which render a diagnosis possible, but the *Conularia* is imperfect and fragmentary.

### BRACHIOPODA.

#### Genus *Spirifer*.

#### *Spirifer byroensis*, sp. nov.

*Spirifer lata* (?) .. Eth. fil Geol Surv. W.A., Bulletin 10, p. 15, plate 1, fig. 8 (1903).

### SPIRIFER BYROENSIS.

This species is represented by specimens more or less spindle-shaped, with sub-acute alar angles, beaks not prominent, rising but little above the cardinal edge, slightly incurved. Hinge line straight, cardinal area moderately wide, concave, transversely striated, as wide as the shell. Ribs radiating, numerous—about 40 on each valve—usually grouped in bundles of three, grouping becomes indistinct towards the wings—where the ribs are irregular and gradually fade away,—alar extremities curved, smooth wing-like. Lines of growth distinct towards the margin. Sinus and fold ribbed. Sinus of the ventral valve extends to the apex of the beak.

Dorsal valve: the cardinal area is rather narrow, cardinal process small, flattened and vertically striated, cardinal sockets long, grooved above, expanded distally. Denticles not observed.

Dimensions of the shell, 37mm. by 103mm.

The *S. lata*? of Etheridge<sup>1</sup> has a costate sinus, acutely extended and nearly smooth alations, which differ in several details from the shell under consideration. The sinus broadens much more rapidly and is less distinct, the alar angles are more acute, the beak is much more prominent, and the ribs lack the tendency to group themselves in bundles.

The fold of the dorsal valve is not grooved as in the *S. lata* from the Queensland Permo-Carboniferous,<sup>2</sup> which shell also possesses plain sulcus and median fold, as well as stronger ribs.

The shell differs from *S. latus* (McCoy) in having fold and sulcus ribbed, in the number of ribs on each valve, and in possessing a cardinal area transversely concave.

*S. convolutus* (Phillips) differs from the new species in the nature and extent of the ribbing, and in possessing much more attenuated (acute) alar angles.

*S. musakheylensis* v. *australis* (Foord), when young, is an alate form with ribs arranged in bundles, but its costation is much finer and the wings are not smooth; it also has a much more prominent beak.

There are five specimens (Nos. 1650-1654) in the collection. The two shells chosen as types (Nos. 1650 and 1651) show the features described above.

#### GASTEROPODA PTEROPODA.

##### *Genus Conularia.*

##### *Conularia*, sp. nov. (?)

c. f. *C. Warthi* . . . Waagen, Pal. Ind., Series XIII., Salt Range Fossils, Vol. IV., p. 126, plate iv., fig. 6, plate v., fig. 1 (1889-1891).

#### CONULARIA, sp. nov.

Three crushed fragments on a piece of ironstone (No. 1660) present the following features:—

Elongated pyramidal shell, quadrangular; faces sub-equal (?), almost flat, slightly grooved in the middle, apical angle unknown,

<sup>1</sup> Loc. cit.

<sup>2</sup> Jack and Etheridge. Geol. and Pal., Queensl., p. 229, 1892.



probably small; folds sharp, narrow, punctate, slightly arched, with the concavity towards the apex, alternating at the side angles, interrupted in the middle of their length but rarely alternating, furrows wide—ten to twelve in the space of 10mm., becoming narrower and more crowded towards the apex—side angles depressed, indistinctly preserved.

This *Conularia* is nearly related to the two Australian species *C. levigata* (Morris)<sup>1</sup> and *C. inornata* (Dana).<sup>2</sup> It differs from both in having its thin, sharp folds punctate; the section of the shell is unknown, as the examples are all fragmentary, but one worn example suggests that the tube was rectangular in section. *C. quadrisulcata* (Miller)<sup>3</sup> has a much greater apical angle, with folds punctate but much more crowded than on the Byro Station fossils.

*Conularia warthi* (Waagen),<sup>4</sup> collected by Dr. Warth in Chél Hill and at Dillur, can hardly be distinguished from the Byro plains shell in its general features, but a most careful examination with a lens failed to reveal the "fine, somewhat irregular, plication that extends transversely over the spaces or valleys between the single ribs," visible on the Indian fossil.

The presence of the inter-costal tubercle at the angles of the tube could not be definitely ascertained owing to the imperfect nature of the fossil.

The *Conularia* clearly shows a closer affinity to this Indian form than to the Permo-Carboniferous species of Eastern Australia.

In his monograph, Dr. Waagen states that the Indian *C. warthi* is associated with the so-called Boulder Beds, which are now considered to be the result of a glacial period of Permo-Carboniferous age. It is of the utmost geological and palaeontological importance to find that a closely allied, if not identical, species of *Conularia* has been obtained from strata intimately connected with the Western Australian Boulder Beds.

The genus has not previously been recorded from Western Australian Sediments.

<sup>1</sup> J. Morris, in Strzetecki's Physical Descriptions of N.S. Wales and Van Diemen's Land, p. 290, plate xviii., fig. 9, 1842.

<sup>2</sup> J. D. Dana. Geol. Wilkes U.S. Expl. Exped., p. 709, plate x., fig. 8, 1849.

<sup>3</sup> Sowerby's Min. Conch. III, p. 107, plate cclx., fig. 5, 1821.

<sup>4</sup> Palaeontologia Indica, Series XIII., Salt Range Fossils, Vol. IV., p. 126, plate iv., fig. 6 a, b, c, d; plate v., fig. 1 a, b.

## NOTES ON SOME WESTERN AUSTRALIAN FISHES.

By ALLAN R. McCULLOCH, Zoologist, Australian Museum.

PLATES IX. to XIII.; text-figures 1, 2.

The Australian Museum has received for identification a large collection of fishes from the Director of the Western Australian Museum and Art Gallery, while several smaller ones have been presented to the Trustees by Mr. A. Abjornssen, Chief Inspector of Fisheries, Western Australia. They include a considerable number of new and little-known species, of which some are dealt with in the following pages. Others not previously recognised from the Western State are recorded.

I wish to express my thanks to Mr. Bernard H. Woodward for enabling me to examine and write upon this extremely interesting collection, and also for various kindnesses connected with the publication of the paper. My thanks are also due to Mr. Abjornssen, who has made special efforts to secure several species I have particularly asked him for.

### GONORRYNCHUS GREYI, Richardson.

*Ryuchana greyi*, Richardson—Zool. Ereb. and Terr., 1845, p. 44, plate xxix., figs 1-6.

*Gonorhynchus greyi*, Günther—Brit. Mus. Cat. Fish, VII., 1868, p. 373 (part); *Id.*, Castelnau, Proc. Zool. Soc. Vict., I., 1872, p. 182; *Id.*, Klunzinger, Arch. fur Nat., XXXVIII., 1872, p. 42, and Sitzb. Akad. Wiss. Wien., LXXX. i., 1879, p. 415; *Id.*, Macleay, Proc. Linn. Soc. N. S. Wales, VI., 1881, p. 255; *Id.*, Johnston, Proc. Royal Soc. Tasm., 1882 (1883), p. 132, and 1890 (1891), p. 37; *Id.*, Ogilby, Proc. Linn. Soc. N. S. Wales, XXIV., 1899, p. 154; *Id.*, Waite, Rec. Austr. Mus., III., 1900, p. 211.

*Gonorhynchus gonorhynchus*, Stead—Proc. Linn. Soc. N. S. Wales, XXXII., 1908, p. 744, and "The Beaked Salmon" (Dept. Fish. N. S. W.), 1908, pp. 1-8, plate 1; *Id.*, Zietz, Trans. Royal Soc. S. Austr., XXXII., 1908, p. 295.

*Gonorhynchus gonorhynchus*, Waite—Trans. N. Zeal. Inst., XLII., 1910, p. 374.

*Gonorhynchus greyi*, Ogilby—Ann. Queensl. Mus., No. 10, 1911, p. 34.

? *Gonorhynchus foisteri*, Ogilby—*Loc. cit.*, and synonymy.

I have compared three Western Australian examples with four others from New South Wales, one from Victoria, and twelve from Lord Howe Island, and find them to be identical. They all differ from Richardson's figure, however, in the proportional lengths of the head and pectoral fins. My series includes specimens from 86-255mm. long. The pectorals are from  $2\frac{1}{4}$ - $2\frac{3}{4}$  in their distance from the ventrals, not  $3\frac{1}{2}$ , as figured. The head varies from  $4\frac{1}{4}$ - $4\frac{3}{4}$  in the length to the hypural; in the figure it is almost six times. The insertion of the dorsal fin also is farther forward in my specimens than shown. It must be noted, however, that Stead figures New South Wales examples, the proportions of which approach Richardson's specimens, while they also agree very well with Hector's figure of one from New Zealand, which Ogilby has called *G. forsteri*.

It therefore seems to me that the length of the body is very variable, as in many other elongate fishes, and that *forsteri* must be regarded as a synonym of *greyi*. If this be accepted, the species is recorded from South-Western Australia, South Australia, Victoria, Tasmania, New Zealand, New South Wales, Lord Howe Island, and the Kermadecs.

Specimens of *G. parvimanus* (Ogilby),<sup>1</sup> of the same size as others of *G. greyi*, have very much smaller heads and pectoral fins, while the scales are cycloid instead of ctenoid. Waite<sup>2</sup> considers the one to be merely the young (larval form) of the other, and the close association of the two over a wide geographical area lends considerable support to the hypothesis. Specimens of the *parvimanus* form are recorded from the following localities:—Lord Howe Island and Narrabeen, New South Wales; Kermadec Islands<sup>3</sup>; Moreton Bay, Queensland. Another is in the Australian Museum from Manly, near Sydney.

The type, which is the largest specimen known, is 88mm. long.

<sup>1</sup> Ogilby. Ann. Queensl. Mus., No. 10, 1911, p. 34.

<sup>2</sup> Waite. Rec. Austr. Mus., V., 1904, p. 147, plate xvii, fig. 3.

<sup>3</sup> Waite. Trans. N. Zeal. Inst., XLII., 1910, p. 374.

## GYMNOTHORAX WOODWARDI, sp. nov.

FIGURE 1.

*Muraena nubila*, Richardson—Zool. Ereb. and Terr., Fishes, 1848, p. 81, part—specimen from Houtmans Abrolhos.

*Muraena richardsonii*, Günther—Brit. Mus. Cat. Fish, VIII., 1870, p. 118—same specimen (not of Bleeker).

*Gymnothorax punctatofasciatus*, Waite—Rec. Austr. Mus., VI., 1905, p. 58 (not of Bleeker).

Head  $2\frac{2}{3}$  in the trunk; head and trunk  $1\frac{1}{4}$  in the tail. Snout  $5\frac{1}{2}$  in the head, mouth  $2\frac{1}{3}$ , eye  $1\frac{2}{3}$  in the snout, and almost equal to the interorbital space.

Body compressed, snout pointed, the tip rounded. Teeth of adults uniserial in both jaws; they are small anteriorly in the upper jaw, then large, and decreasing again backwards. In a small example there are one or two large canines inside the others near the middle of the jaw. Mandibular teeth decreasing regularly from front to back. One or two large depressible teeth on the median line of the mouth anteriorly; vomerine teeth uniserial, small, and mostly rounded. Gill-opening smaller than the eye. Origin of the dorsal, midway between the end of the mouth and the gill-opening.

Colour.—Light brown after long preservation in spirits, darker posteriorly, with a wide meshed network of dark lines on the upper half of the body. A dark line near the back begins with the dorsal and follows it until it is lost on the tail; this line is not very distinct in my smallest specimen. Some black lines extend from behind the mouth towards the gill-opening; head otherwise plain. Anteriorly the dorsal and anal fins are marked like the body, but posteriorly they are very dark with whitish margins.

Described from five specimens, 325-720mm. long, from near Fremantle, Houtmans Abrolhos, and Pelsart Island. The type, which is 515mm. long, is from the latter locality, and is in the Western Australian Museum.

An eel in the British Museum, from Houtmans Abrolhos, was identified by Richardson as his *Muraena nubila*, and later by Günther as *M. richardsonii*, Bleeker; it is probably of the same species as the specimens described above. Mine differ from the figures of both *nubila* and *richardsonii*, however, in the arrangement of the dark marking

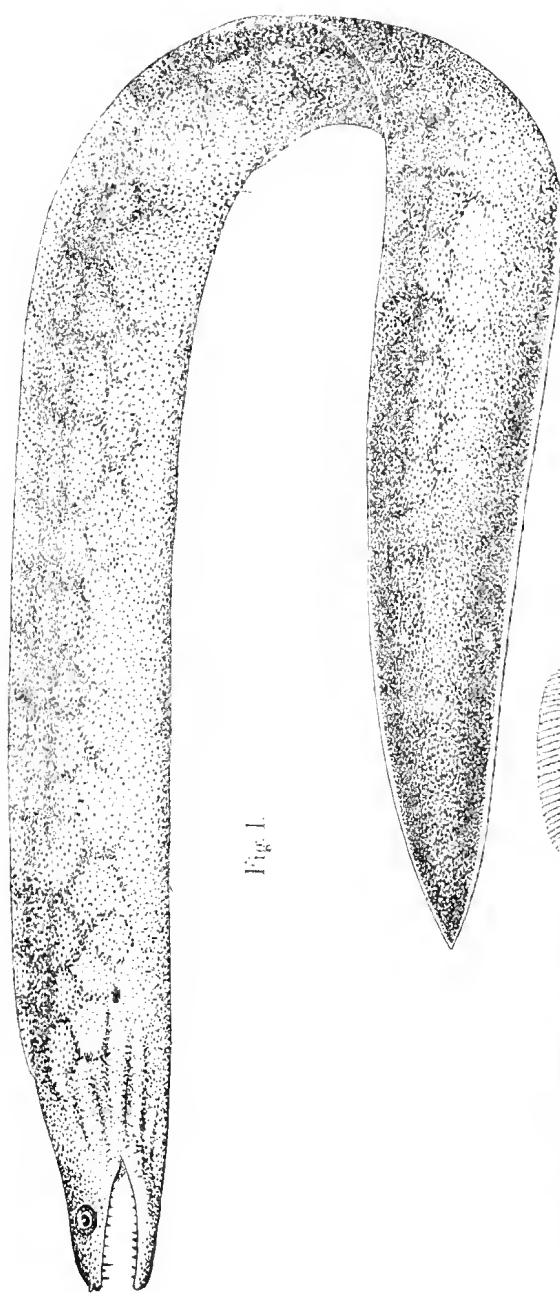


Fig. 1.

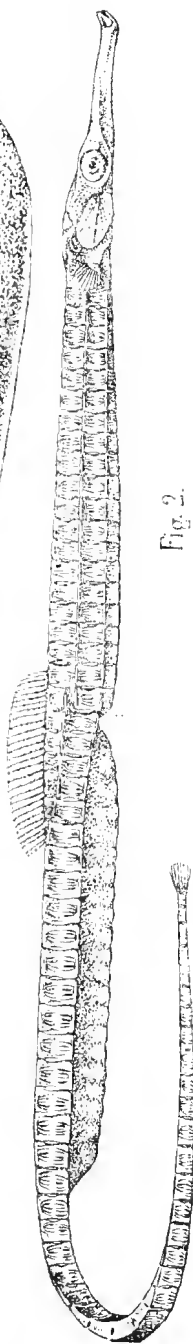


Fig. 2.

FIGS. 1 AND 2.

on the body, which is apparently very characteristic. Again, my smallest specimen is one of the three identified by Waite as *Gymnothorax punctatofasciatus*, Bleeker; I consider that its colour pattern separates it from these species also.

## CORYTHOICHTHYS POECILOLAEMUS, Peters.

FIGURE 2.

*Syngnathus poecilolaemus*, Peters—Monatsb. Akad. Wiss. Berlin, 1868 (1869), p. 458; *Id.* Zietz, Trans. Roy. Soc. S. Austr. XXXII., 1908, p. 298.

*Syngnathus poecilolaemus*, Duncker—Faun. Sudwest-Austr., II., 1909, p. 245 (see references).

D. 28. P. 12. C. 10. Rings 19+48. Head  $1\frac{9}{10}$  in the trunk. Head and trunk  $1\frac{1}{2}$  in the tail. Snout one third longer than rest of head. Eye less than one fourth as long as the snout, and 2 in postorbital portion of head.

Snout with ridges but not serrated; a median keel extends from the mouth to the occiput, but is very low anteriorly and is interrupted between the eyes. The supraorbital ridges commence some distance before the eyes, and extend backward to the occiput; interorbital space concave. Nuchal keel low but distinct. Operculum with a prominent median keel. Body rings without spines. Trunk  $1\frac{1}{2}$  as deep as broad, its greatest depth being near the vent. Dorsal fin opposite the vent, occupying  $1\frac{1}{2} + 6$  rings; its base not raised above the level of the back. Median lateral ridge ending on the last body ring, and just below the origin of the upper caudal edge. Edges of the back extending to the end of the dorsal fin. Lower lateral edges of the body continuous with those of the tail. Caudal fin, small, shorter than the eye. Egg pouch very large, occupying 18 tail rings and containing 58 large eggs disposed in two, or in places, three rows.

Colour.—Uniform brown in spirit, the snout with darker cross bars. Body with numerous minute ocelli.

Described from a single example, 197mm. long, from Fremantle, and the property of the Western Australian Museum.

## SYNGNATHUS (YOZIA) TIGRIS, Castelnau.

PLATE, XI.; FIG. 2.

*Syngnathus tigris*, Castelnau—Proc. Linn. Soc. N. S. Wales, III, 1879, p. 397; *Id.*, Macleay, *loc. cit.*, VI., 1881, p. 227; *Id.* Stead, *loc. cit.*, XXXI., 1906, p. 428; *Id.*, Duncker, Faun. Südwest-Austr. II., 1909, p. 245

D. 24-25. P. 15. C. 8. Rings 17 + 36. Head  $3-3\frac{1}{3}$  in the trunk. Head and trunk  $1\frac{2}{3}$  in tail. Snout  $1\frac{3}{4}-1\frac{5}{8}$  in rest of head. Eye  $2\frac{1}{3}-2\frac{3}{4}$  in snout, and 2 in postorbital portion of head.

Snout rugose but not serrated, with a median keel before the eyes which is more or less bifurcate between the eyes. Interorbital space concave. Head granular, operculum with radiating lines, but without a median keel. Occiput and nape with a sharp, raised keel; body rings without spines. Trunk deeper than broad, the breast more or less swollen; depth between the upper and lower lateral edges of the trunk rather less than the length of the snout. Dorsal fin opposite the vent, occupying  $2\frac{1}{2}-3+2-2\frac{1}{2}$  rings, its base elevated. Median lateral ridge continuous with the lower caudal edge; upper edge extending over  $1-1\frac{1}{2}$  body rings. Lower surface of the tail much broader than the upper. Caudal fin, large, two-thirds as long as the snout.

Colours.—Light brown in spirits, each ring with a more or less distinct ocellus above the lateral ridge, and on the sides of the tail; a dark-edged, semioval pearly spot on the edge of each body segment. Operculum with several oblique dark lines. Body with three darker cross bars, and tail with about seven more.

Described from three specimens 265-280mm. long, from Port Jackson, the largest of which is the specimen figured (Reg. No. 1. 12073).

A single specimen from Fremantle differs only in having the head more rugose, the opercular markings broader, and nine instead of seven cross bands on the tail.

According to Castelnau, the upper edge on the tail and the lateral line are continuous, but in all the specimens I have seen, the latter joins the lower edge above the vent. Through the kindness of Mr. Stead, I have examined the specimen he recorded from

the Hawkesbury River, while Mr. Ogilby informs me that according to his notes, the lateral ridge is always continuous with the lower caudal edge. I therefore regard the original description as incorrect in this detail.

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## CYPSELURUS KATOPTRON, Bleeker.

*Exocoetus katoptron*, Bleeker—Ned. Tydschr. Dierk., III., p. 115; *Id.*, Günther, Brit. Mus. Cat. Fish., VI., 1866, p. 289; *Id.* Bleeker, Atl. Ichth., VI., 1871, p. 72, pl. CCXLVII., fig. 3.

*Cypsilurus katoptron*, Jordan and Seale—Bull. U.S. Bur. Fish., XXV., 1906, p. 211, fig. 16.

A large specimen from Fremantle differs from Jordan and Seale's excellent figure only in having a slightly larger eye, and thirteen instead of fourteen dorsal rays, but in both these details it is in agreement with Bleeker's description.

It differs from Günther's description of *Exocoetus robustus*<sup>1</sup> in having the interorbital space concave instead of flat, and in the position of the ventral fin which is inserted farther back. Jordan and Seale consider *C. robustus* and *C. katoptron* identical, notwithstanding that Günther had Bleeker's type before him for comparison.

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## PARAPLESIOPS MELEAGRIS, Peters.

### PLATE IX.

*Plesiops meleagris*, Peters—Monatsb. Akad. Wiss. Berlin, 1869 (1870), p. 708.

*Ruppelia prolongata*, Castelnau—Res. Fish. Austr. (Vict. Rec. Philad. Exhib.), 1875, p. 29 (not *R. prolongata*, Cast., 1873).

*Paraplesiops meleagris*, Boulenger—Brit. Mus. Cat. Fish., 1895, p. 339.

A specimen from near Fremantle is in the Western Australian Museum, and another from the same locality was presented to the Australian Museum by Mr. A. Abjornssen. It is figured on plate I. (Reg. No. I. 11232).

Though the species has not been recognised from Western Australia under this name, there can be no doubt that the second specimen identified by Castelnau as *Ruppelia prolongata*, was really *P. meleagris*.

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<sup>1</sup> Günther, *loc. cit.*



## BOSTOCKIA HEMIGRAMMA, Ogilby.

PLATE X; FIG. 3.

*Bostockia hemigramma*, Ogilby—Proc. Linn. Soc. N. S. Wales, XXIV., 1899, p. 168.

The collection includes a small specimen of this species from the Helena River, near Perth, and two others from the same locality are in the Australian Museum. The largest of these, 155mm. long, is the one selected for illustration. I have compared it with a co-type in the museum collection, so that, although its proportions differ somewhat from the smaller ones described by Ogilby, I have no doubt of its correct identification.

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## EDELIA, Castelnau.

*Edelia*, Castelnau—Proc. Zool. Soc. Vic., II., 1873, p. 123 (*vittata*); *Id.*, Ogilby, Proc. Linn. Soc. N. S. Wales, XXIV., 1899, p. 175.

As all my specimens, including two examined by Ogilby, differ in some important details from that author's definition of this genus, I have drawn up the following corrected diagnosis. The items in brackets are as stated by Ogilby.

Body oblong, compressed. Scales, large, adherent, finely ciliated, concentrically striated. Lateral line interrupted below the second dorsal (complete), the tubes few, irregular, simple, extending along the entire exposed surface of the scale. Head moderate, largely scaly, snout and lower jaw naked. Mouth with small oblique cleft; jaws equal. Premaxillaries protractile; maxillary exposed at distal extremity only, naked. Bands of slender villiform teeth in the jaws, a large patch on the vomer, and a few on the anterior part of the palatines (not seen by Ogilby); pterygoids and tongue smooth. Nostrils distant, simple. Eyes moderate, lateral, high. Preorbital denticulate. Preopercle entire. Operculum with two spines. Gill-openings wide, the membranes united in front, free from the isthmus; 5-6 branchiostegals. Pseudobranchiae present. Gill-rakers moderate, few. Two dorsal fins connected at the base, the first with 7-8 spines and longer than the second; the

second with 1 spine and about 9 rays. Anal short, with 3 spines and about 8 rays. Ventrals inserted behind the base of the pectorals, close together, with a strong spine and 5 rays. Pectorals rounded, with 11-13 rays. Caudal slightly rounded. Vertebrae 13+15 (12+18).

This genus is evidently closely allied to *Nannoperca*, Günther.

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## EDELIA VITTATA, Castelnau.

PLATE XI.; FIG. 2.

*Edelia vittata*, Castelnau—Proc. Zool. Soc. Vict., II., 1873, p. 124; *Id.* Ogilby, Proc. Linn. Soc. N. S. Wales, XXIV., 1899, p. 176.

*Edelia viridis*, Castelnau—*loc. cit.*, p. 125.

There are twenty specimens in the Australian Museum, of which two from the Leschenault Inlet were received from Mr. A. Abjornssen. Two more from Donnybrook, in the County of Wellington, were some of those used by Ogilby in drawing up his description, while sixteen others without a definite locality were received from Mr. Albert Gale.

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## GLAUCOSOMA HEBRAICUM, Richardson.

*Glaucosoma hebraicum*, Richardson—Voy. Ereb. and Terr., Fishes, 1846, p. 27, pl. XVII., *Id.*, Saville Kent, Nat. in Austr., 1897, p. 177, pl. XXX.

*Glaucosoma burgeri*, Günther—Brit. Mus. Cat. Fish, I., 1859, p. 211 (part).

Fresh specimens of this species show striking dark longitudinal bands, the most prominent of which follows the lateral line, and is rather wider than the scales it covers. There are two broader ones between it and the back, each covering two rows of scales, while below it are three others which are still broader. A dark bar passes obliquely from the eye to the interopercle. The fins are dusky, but the tips of the anal and dorsal spines and the anterior margins of the fins are whitish, and there are oblique whitish bars on the ends of the caudal lobes.

Although I have carefully compared my two specimens with Jordan and Thompson's<sup>1</sup> excellent description and figure of *G. burgeri*, Richardson, I am unable to find any satisfactory differences

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<sup>1</sup> Jordan and Thompson, Proc. U. S. Nat. Mus., XXXIX., 1911, p. 440.

between the two species that may not possibly be accounted for by variation with growth, etc. Both my specimens, however, have the fourth dorsal rays longest, so that the fins are angular in form instead of rounded. Minute palatine teeth are present in both, but are very indistinct and easily overlooked in one of them. As suggested by Jordan and Thompson, it will be necessary to compare specimens of both species before the characters separating the two can be positively determined.

Both specimens were obtained near Fremantle, W. Australia.

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## SILLAGO BOSTOCKII, Castelnau.

PLATE X., FIG. 1.

*Sillago ciliata vel bostockii*, Castelnau—Proc. Zool. Soc. Vict., II., 1873, p. 133.

*Sillago bostockii*, McCulloch—"Endeavour Report," fishes (in press), pp. 60, 63.

D. XI., 21-22; A. 19-22; P. 15-16; V. 1., 5; C. 17; l. lat. 69-74; l. tr. 6+14.

Head  $3\frac{1}{2}$ - $3\frac{3}{4}$ , depth  $5$ - $5\frac{1}{2}$  in the length to the hypural. Eye  $5$ - $5\frac{1}{2}$ , snout  $2\frac{2}{3}$ , pectoral  $1\frac{2}{3}$ - $1\frac{3}{4}$  in the head. Interorbital width  $\frac{2}{3}$ - $\frac{3}{4}$  the eye.

Body elongate, compressed, the dorsal profile rather more arched than the ventral. Caudal peduncle much compressed, its depth almost equal to the postorbital portion of the head. Eye large, nearer the end of the operculum than the tip of the snout. Interorbital space flat. Preoperculum crenulate, a broad flat spine on the operculum. Mouth small, oblique, the maxillary a little longer than half the snout. Nostrils close together, near the eye, the anterior with a skinny lobe. A broad band of villiform teeth on each jaw, the outer ones of the upper jaw somewhat enlarged; a broad horseshoe shaped band on the vomer. Gill-rakers short and thick, tubercular below, nine on the lower limb of the first arch.

Scales finely ctenoid, extending forward to the nostrils on the upper surface of the head; arranged in four rows on the cheeks. Snout and lower part of the head bare. Basal portion of the caudal fin densely scaly, while rows of small scales are present behind each ray of the other fins. Lateral line a little arched anteriorly, thence straight to the caudal peduncle, and continued on to the fin to the end of the middle rays.

Dorsal fins separate or united by a low membrane; the first is inserted well behind the ventrals, the second just in advance of the vent and terminating far behind the anal. Pectoral and ventral pointed, the outer ray of the latter sometimes produced. Caudal emarginate.

Colour.—Sandy yellow, the upper parts closely speckled with minute grey dots. Both dorsal fins have from three to five longitudinal rows of large grey spots. Well preserved specimens have a dark (silvery?) band from above the base of the pectoral to the caudal peduncle. No dark mark at the base of the pectoral.

This is apparently the common whiting near Fremantle; a large number of specimens being included in the Western Australian Museum collection, while an excellent series was secured for the Australian Museum by Mr. Abjornssen. Specimen selected for illustration registered I. 11334.

## THERAPON CAUDAVITTATUS, Richardson.

*Datna caudavittata*, Richardson—Voy. Ereb. and Terr., Fishes, 1848, p. 24, pl. XVIII., fig. 3-5.

*Therapon caudovittatus*, Günther—Brit. Mus. Cat. Fish. I., 1859, p. 284; *Id.*, All. and MacI., Proc. Linn. Soc. N. S. Wales, I., 1877, p. 270; *Id.*, MacI. *loc. cit.*, II., 1878, p. 348; *Id.*, Castelnau, *loc. cit.*, III., 1878, pp. 42 and 47; *Id.*, Klunz. Sitzb. Ak. Wiss. Wien., LXXX., I., 1879, p. 350; *Id.*, Waite, Rec. Austr. Mus., III., 1900, p. 210.

*Therapon caudovittatus?* *vel bostockii*, Castelnau.—Proc. Zool. Soc. Vict., II., 1873, p. 128.

I have examined nine specimens of this fish from Fremantle, W. Australia, and two from Murray Island, Torres Strait, but in none are the sub- and interoperculum serrated as described by Richardson. There are also 25 instead of 20 transverse series of scales, so that in both these details they agree better with his figure than his description.

Castelnau proposed the name *bostockii* for Fremantle specimens of *caudavittatus*, which differed from the description given by Günther in having the dorsal fin notched, and the last spines much shorter than the rays. This, however, is the normal form, and it is doubtful if Günther has correctly described his specimens.

## SPARUS SARBA, Forskal.

*Pagrus sarba* (Forskal), Ogilby—Ed. Fish. N.S. Wales, 1893, p. 50, pl. XIV.

*Chrysophrys sarba*, Stead—Ed. Fish. N. S. Wales, 1908, p. 78, pl. XLVII.

Eight specimens are in the collection, from the neighbourhood of Fremantle, which agree in every way with others from Port Jackson. This species does not appear to have been recognised from the western coast of Australia.

## SPARUS AUSTRALIS, Günther.

*Chrysophrys australis*, Günther—Brit. Mus. Cat. Fish. I., 1859, p. 494; *Id.*, Stead, Ed. Fish. N. S. Wales, 1908, p. 77, pl. XLVI.

I am unable to separate four specimens, from Fremantle, from this species. It has been recorded from the Harvey River, Western Australia, by Günther.

## PLATAX TEIRA, Forskal.

*Platax teira* (Forskal), Jordan and Fowler—Proc. U. S. Nat. Mus., XXV., 1902, p. 256.

A very small specimen, one and a half inches long, from Fremantle, is of interest as being apparently the first of the species recognised from Western Australia.

## LEPIDAPLOIS VULPINUS, Richardson.

*Cossyphus vulpinus*, Richardson—Proc. Zool. Soc., 1850, p. 71.

*Harpe vulpina*, Waite—Rec. Austr. Mus., IV., 1902, p. 269, pl. XLIII. and VI., 1905, p. 70.

*Trochocopus rufus*, Macleay—Proc. Linn. Soc. N. S. Wales, III., 1878, p. 35, pl. V, fig. 3.

*Cossyphus frenchii*, Klunzinger—Sitzb. Akad. Wiss. Wien, LXXX., i., 1879, p. 400; *Id.*, Macleay, Proc. Linn. Soc. N. S. Wales, IX., 1884, p. 46.

*Cossyphus aurifer*, De Vis—Proc. Roy. Soc. Qld., I., 1884, p. 146.

The collection includes a specimen from Abrolhos Island, which agrees very well with Waite's figure of *Harpe vulpina*. I have compared it with the types of *Trochocopus rufus*, Macleay, with which it is identical. According to Macleay's description there are 45 scales on the lateral line, but in both his specimens there are only 36. This detail is referred to by Klunzinger, and as *Trochocopus* has 45 or more, he placed the species in *Cossyphus*. Further,

there being already a *Cossyphus rufus*, and as he did not recognise its identity with the earlier *C. vulpinus*, he changed the name to *C. frenchii*.

Mr. Ogilby has kindly examined the type specimen in the Queensland Museum of *Cossyphus aurifer*, De Vis, for me, and writes that he considers it identical with the species figured by Waite.

## PSEUDOLABRUS PARILUS, Richardson.

### PLATE-XII.

*Tautoga parila*, Richardson—Proc. Zool. Soc., 1850, p. 70.

*Labrichthys parila*, Castelnau—Proc. Zool. Soc. Vict., II., 1873, p. 137.

D. IX., 11.; A. III., 10; P. 13; V. I., 5; C. 12-13; l. lat. 26; l. tr. 3-4+9. Height  $3\frac{1}{4}$  in the length to the hypural, and equal to the length of the head including the opercular flap. Eye 5, snout  $3-3\frac{1}{2}$ , caudal peduncle  $1\frac{8}{10}$  in the head.

Body moderately elongate, compressed, covered with large scales which extend on to the nape and the caudal fin, but not over the bases of the dorsal and anal. A single series of small and imperfect scales from behind the eye to the cheek, and other large and irregular ones covering the operculum; head otherwise naked and closely pitted with minute pores. Preorbital narrower than the eye. A pair of strong canines in front of each jaw, those of the upper separated; sides with a single series of smaller canine-like teeth decreasing in size backwards, and a second inner series of very small ones anteriorly. Posterior canines present. Nostrils close together near the supero-anterior angle of the eye; the anterior tubular, posterior simple. Lateral line following the curve of the back over 20 scales, then bending downward, two rows to the middle of the caudal peduncle; the ramifications of the tubules cover all the exposed portions of the scales except the extreme edges.

Dorsal fin commencing above the hinder half of the operculum. Spines increasing in length backwards, the last  $2\frac{3}{4}$ -3 in the head, and each topped by a prolongation of the membrane. Soft portion of the pin angular behind, the anterior rays longer than the posterior;  $2\frac{1}{4}$  in the head. Anal similar to, and terminating a little in advance of the dorsal. Pectoral  $1\frac{1}{2}$  in the head, the upper rays longest, margin rounded. Ventral pointed, second ray not quite reaching to the vent. Caudal rounded.

Colour:—Greenish, spotted with brown, the spots tending to form indistinct bands in one specimen but not in the other. Brown lines radiate from the eye and on to the operculum. Broad darker markings enclosing light interspaces are distinct in one specimen on the lower parts of the head. Dorsal and anal with darker and lighter spots on the rays, and there is a larger spot between the first and second spines of the former.

Described from two specimens, 200 and 225mm. long, in the Australian Museum (L. 11459 and 11461), received from Mr. A. Abjornssen who collected them at Fremantle.

Castelnau recorded this species from Port Jackson,<sup>1</sup> but it has not been again recognised from eastern Australia by any other author. I suggest that his specimen was merely one of the variations of *P. gymnogenys*, Günther, as I have a local example of that species with which his colour-notes agree very well.

Having compared the specimens identified by Waite<sup>2</sup> as *P. ruber*, Castelnau, with the two described above, I think it possible that the former will prove to be either an older or sexual form of *P. parilus*. Though the differences between Waite's figure and my own appear very great, some of the specimens nevertheless exhibit certain characters which are intermediate between the two extremes, while Castelnau's notes on the colour of Western Australian examples of *P. parilus* agree as well with his own as with Richardson's species.

## PSEUDOLABRUS BOSTOCKII, Castelnau.

PLATE XI ; FIG. 1.

*Labrichthys tetraca*, Günther—Brit. Mus. Cat. Fish, IV., 1862, p. 116 (part).

*Labrichthys bostockii*, Castelnau—Proc. Zool. Soc. Vict., II., 1873, p. 137; *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, VI., 1881, p. 85.

*Labrichthys biserialis*, Klunzinger—Sitzb. Akad. Wiss. Wien, LXXX. I., 1879, p. 402.

*Pseudolabrus tetricus*, Waite—Rec. Austr. Mus., VI., 1905, p. 70 (*nec* Richardson)

D. IX., 11; A. III., 10; P. 12; V. I., 5; C. 13-14; l. lat. 25-27; l. tr. 4+8.

Height of body  $3\text{--}3\frac{1}{4}$  in the length to the hypural, a little

<sup>1</sup> Castelnau, Proc. Linn. Soc. N. S. Wales, III., 1879, p. 389.

<sup>2</sup> Waite, Rec. Austr. Mus. IV., 1902, p. 185, pl. XXVIII.

greater than the length of the head without the opercular flap. Eye  $4\frac{1}{2}$ -5, snout 3, caudal peduncle  $2\frac{1}{4}$  in the head. Interorbital width  $1\frac{1}{2}$  in the snout.

Body moderately elongate, compressed, covered with large scales which extend forwards on to the nape, and on to the bases of the dorsal, anal, and caudal fins. Two oblique rows of small scales from behind the eye to the cheek, and other larger and irregular ones covering the operculum; head otherwise naked. Preorbital either a little broader than or narrower than the eye. A pair of strong canines in front of each jaw, those of the upper being widely separated; sides with a single series of smaller canine-like teeth decreasing in size backward, and usually a second inner series of very small ones anteriorly. Posterior canines present, sometimes double. Nostrils placed close together near the supero-anterior angle of the eye; the anterior tubular, posterior slit-like. Lateral line following the curve of the back over 19-20 scales, then bending downward two rows to the middle of the caudal peduncle; anteriorly the tubes are much branched, simpler posteriorly.

Dorsal fin originating over the hinder half of the operculum. Spines low, each topped by a prolongation of the membrane; rays subequal, soft portion of the fin angular posteriorly. Anal similar to the dorsal. Caudal truncate, the tips usually a little produced. Upper rays of pectoral longest, the lower half of the fin rounded. Ventrals pointed, not reaching to the vent.

Colour.—Red, darker above, each scale with a large carmine spot. A yellow band extends from above the base of the pectoral to the middle of the caudal peduncle. Dorsal black basally, then clear orange, and margined with a narrow violet line. Anal blood red with a broad violet edge, and with or without indications of a darker median band. Caudal orange with a darker edge. Pectorals and ventrals pink, the former with a black basal band. After long preservation almost all traces of the colour markings disappear, leaving only the darker fin markings.

Described from six specimens, 160-200mm. long, one of which is from near Albany, another from Mandurah, and four from Fremantle. I am indebted to Mr. A. Abjornssen for beautifully preserved examples of this species from which the accompanying figure has been prepared.



I follow Klunzinger in regarding his *P. biserialis* distinct from *P. tetricus*, Richardson, but consider that it is identical with *P. bostockii*. Waite united the latter with *P. tetricus*, but they appear to differ in the arrangement of the scales on the cheeks and in the form of their fins.

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### MUCOGOBIUS, gen. nov.

Body oblong, compressed behind. Head a little compressed, scaleless, but with many horizontal and vertical raised mucous ridges, which also extend on to the body; no true barbels. Snout rounded, lower jaw the longer; mouth oblique. Eyes large, close together. Opercles unarmed. A band of simple villiform teeth in each jaw, the outer ones somewhat enlarged; vomer and palatines toothless. Tongue rounded. Isthmus broad. Scales moderate, largest posteriorly, cycloid. Dorsal with six spines and about ten rays. Anal similar to the soft dorsal. Ventrals I. 5, united, not adnate to the belly. Pectorals pointed, without free silk-like rays. Caudal rather lanceolate, produced.

Type.—*Gobius mucosus*, Günther.

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### MUCOGOBIUS MUCOSUS, Günther.

*Gobius mucosus*, (Günther), Waite—Rec. Austr. Mus., VI., 1906, p. 200.

The collection includes three from Fremantle, while another was collected by Mr. Abjornssen near Albany.

I am unable to associate this species with any genus known to me, and therefore propose *Mucogobius* for it as above.

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### SCORPAENA, Linnaeus.

*Scorpaena*, Linnaeus—Syst. Nat., 10th Ed., 1758, p. 266 (*porcus*); *Id.*, Jordan and Starks, Proc. U.S. Nat. Mus. XXVII., 1904, p. 131.

*Sebastapistes*, Gill, in Streets—Bull. U.S. Nat. Mus., No. 7, 1877, p. 62 (*strongia*); *Id.*, Jordan and Evermann, Bull. U.S. Fish., Comm., XXIII., pt. 1, 1905, p. 455.

The genus *Sebastapistes*, is apparently distinguished from *Scorpaena* only by the armature of the preorbital and its smaller size. Some large Australian species have strong recurved spines on the

preorbital, and being unable to satisfactorily divide up those I have examined into the two genera, I prefer to regard Gill's genus as a synonym of *Scorpaena*.

The following is a key to the Australian species available to me.

- a. 50-55 rows of scales just below the lateral line. A more or less prominent median keel on the anterior portion of the interorbital space. *cardinalis*.
- aa. 45 or fewer rows of scales.
- b. Transverse hollow behind the eyes, distinct but shallow.
- c. Two prominent interorbital ridges ending in spines. Third dorsal spine generally longest. *cruenta*.
- cc. Interorbital ridges low, without spines. Fifth dorsal spine generally longest.
- d. Head and body with numerous tentacles. *bynoensis*.
- dd. Head and body with but few tentacles. var. *laotale*.
- bb. Transverse hollow very deep. Interorbital ridges almost obsolete. *sumptuosa*.

### SCORPAENA CARDINALIS, Richardson.

*Scorpaena cardinalis*, Richardson—Ann. Mag. Nat. Hist., IX., 1842, p. 212; *Id.*, Günther, Brit. Mus. Cat. Fish., II., 1860, p. 116.

*Scorpaena jacksoniensis*, Steindachner—Sitzb. Ak. Wiss. Wien., LIII., I., 1866, p. 438, pl. III., fig. 2, 2a.

*Scorpaena cruenta*, Ogilby—part, Ed. Fish. N. S. Wales, 1893, p. 63, pl. XX.; *Id.*, Waite, Mem. Austr. Mus., IV., 1899, p. 99; *Id.*, Stead, Ed. Fish. N.S. Wales, 1908, p. 108, pl. LXXV. (not *S. cruenta*, Richardson).

This species, and not *S. cruenta*, Richardson, is apparently the common Red Rock Cod of the Sydney fishermen. I have examined the specimens identified by Ogilby, Waite, and Stead as *cruenta*, and regard almost all of them as being *cardinalis*; only two small ones from Port Jackson being the former species. Mr. Stead informs me that there is but one common species in the Sydney Markets, of which his specimens are representative, so that *S. cruenta* will probably prove to be a rare species here. Besides the two Port Jackson specimens, I have examined several others from Tasmania, and find that they differ from *cardinalis* in having much larger scales, and in having the interorbital ridges ending in acute spines.

Günther<sup>1</sup> has united *S. jacksoniensis*, Steindachner, with *S. bynoensis*, Richardson, but Klunzinger<sup>2</sup> has shown that this is

<sup>1</sup> Günther, Zool. Rec., 1866 (1867), p. 143.

<sup>2</sup> Klunzinger, Sitzb. Ak. Wiss. Wien, LXXX. I., 1879, p. 366.

incorrect. It differs in the form and disposition of its cephalic spines, smaller scales, general proportions, and colouration. I can find no difference between it and *S. cardinalis*.

## SCORPAENA SUMPTUOSA, Castelnau.

PLATE XIII.

*Scorpaena sumptuosa*, Castelnau—Res. Fish., Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p. 17; *Id.*, Macleay, Proc. Linn. Soc., N. S. Wales, V., 1881, p. 432.

D. XI., I. 9-10; A. III., 5; V. I. 5; P. 16; C. 13.

Depth  $2\frac{1}{3}$ - $2\frac{1}{2}$ , head  $2\frac{1}{2}$  in the length to the hypural. Eye  $4\cdot4\frac{1}{3}$ , caudal peduncle  $3\frac{1}{4}$  in the head.

Dorsal profile highest at the base of the third dorsal spine, thence descending rapidly to the tail. Head armed with strong spines and largely covered with glandular skin, only a few scales being present on the end of the operculum. Interorbital space deeply concave with a very low median ridge anteriorly, and defined posteriorly by a raised sinuous bone. A deep transverse hollow behind the eyes divided into four parts by three longitudinal ridges, the two exterior of which have each a small spine in front. Eye with a broad spine anteriorly, and two on the upper margin. Nasal spines simple or bifurcate. Preorbital with a rosette of sinuous bony ridges. A ridge with three or four spines extends across the cheek, and there are two more on the preopercular margin on the same line; below these the margin is armed with four more points. Superior opercular spine inclined upwards, the lower extending forwards as a prominent curved ridge. There is a small bifurcate spine behind the eye, and two larger ones with broad bases between it and the upper opercular margin. Nuchals large, each with two points; a very small spine between them and the operculum. Maxillary extending beyond the eye, and two-thirds as wide as it posteriorly. Bands of villiform teeth on the jaws, vomer, and palatines. Gill-rakers short, thick, and spiny.

Scales large, cycloid, extending forward to just in front of the dorsal fin; six or seven between the lateral line and the twelfth dorsal spine, and about fifteen more to the vent. The lateral line is formed of about twenty-one tubes, and there are forty-four rows of scales directly below it. Skinny lobes are distributed at intervals all over the body, but are most numerous on the back and the lateral line.

First dorsal high, the third spine the longest and about two-thirds as long as the head; eleventh spine very short, one third as long as the twelfth. Anterior rays of the soft dorsal sub-equal, the margin rounded posteriorly. Second anal spine longest, very strong and laterally grooved; soft portion of the fin rounded. Pectoral reaching to, or not so far as the origin of the anal; it has nine or ten simple lower rays. Ventrals rounded, reaching to, or almost to the vent. Caudal rounded.

Colour.—Yellowish or reddish with darker marblings. Lower parts of the head and body with numerous irregular dark spots. Spinous dorsal marbled with reddish brown, and with or without a large dark blotch on the hinder part. Soft dorsal, caudal, and anal with red and brown spots forming irregular rows. Pectorals also spotted, ventrals plain.

Described from two specimens 310mm. and 300mm. long, the first from Fremantle, and the property of the Western Australian Museum, and the second from Albany, and in the collection of the Australian Museum. A third is also in the Australian Museum from Houtmans Abrolhos.

This species is allied to *S. cardinalis*, Richardson, but is at once distinguished by having only forty-four instead of fifty-five rows of scales below the lateral line, and in lacking the high median keel on the anterior part of the interorbital space. According to Castelnau his specimen had only ten spines in the first dorsal, but as this is an unusual number in the genus, and as my specimens agree in every other detail, I have no doubt that they are really *S. sumptuosa*.

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### SCORPAENA BYNOENSIS, Richardson.

*Scorpaena bynoensis*, Richardson—Voy. Ereb. and Terr., 1845, p. 22, pl. XIV., fig. 3-4; *Id.*, Klunzinger—Sitzb. Ak. Wiss. Wien., LXXX. I, 1879, p. 366 (synonymy).

*Sebastapistes laotale*, Jordan and Seale—Bull. U.S. Fish. Bur., XXV., 1906, p. 376, fig. 72 (variety).

I have very carefully compared thirty-two examples of this species from various localities and find that they vary considerably in the development of the tentacles and cirri on the head and body. In one from Dunk Island, Queensland, the orbital tentacles are nearly twice as long as the eye, and other large ones are present on

the spines and margins of the bones; in others from Murray Island, Torres Strait, all but the nasal tentacles are wanting. The first represents the form named *bynoensis*, while the others agree with *laotale*, of which I have examined a co-type, but as my series exhibits every stage between the two, the latter must be regarded merely as a variety of the former.

Of the thirty-two specimens, one has thirteen spines and nine dorsal rays, another eleven spines and ten rays, while all the rest have twelve spines and ten rays. The length of the posterior spine is variable, while the colour may be anything from ashy grey to brilliant brown and white, though the characteristic colour pattern is always more or less maintained.

My specimens come from Dunk Island and Green Island near Cairns, Queensland; Murray Island, Torres Strait; Mapoon, Gulf of Carpentaria; Port Darwin and Western Australia.

I regard the New South Wales and New Zealand records of this species as very probably incorrect since it is an inhabitant of coral reefs, etc., and is doubtless confined to the tropics. Günther's association of *S. jacksoniensis*, Steindachner, with *bynoensis* seems to have been the cause of its first inclusion in the New South Wales lists, but this is shown to be incorrect (see *ante*). Ogilby included it in his Edible Fishes of N. S. Wales,<sup>1</sup> but as there are no local specimens in the collection of the Museum, and as Mr. Stead informs me that he has not seen any specimens in the markets, I think its occurrence here needs verification.

*S. bellicosa*, Castelnau,<sup>2</sup> from Nicol Bay, Western Australia, and Queensland is apparently very similar to *S. bynoensis*, but is described as having prominent interorbital ridges, whereas they are low in Richardson's species. Castelnau's specimens may have been dried, as were many others in his collection, in which case the flesh shrinking from the bones would make the ridges appear more prominent, so that this difference is probably of little importance.

<sup>1</sup> Ogilby, Edible Fish, N. S. Wales, 1893, p. 65.

<sup>2</sup> Castelnau, Res. Fish., Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p. 17.

## A VISIT TO BERNIER AND DORRÉ ISLANDS

DURING AUGUST AND SEPTEMBER, 1910.

BY

OTTO LIPFERT

PLATES XIV. TO XVI.

The best time to visit Bernier and Dorré Islands is immediately after the rainy season, when the wild flowers are in full bloom. Parts of Dorré Island then resemble a brilliant flower garden; however, the blooms do not last long, for during October the sun scorches everything except the salt bush and spinifex.

There is little animal life; even the sea birds are by no means abundant, and as the aborigines, for whose benefit these islands have been reserved, are to some extent dependant for food on the result of their success in hunting, the wallabies and bandicoots will soon become extinct.

The Wallabies, of which three species are to be found, are not at all numerous. They are *Lagostrophus fasciatus*, the Banded Wallaby; *Lagorchestes hirsutus*, the Hare Wallaby, of which there are two sub-species, *bernieri* and *dorree*; and *Bettongia lesueuri*, commonly called Lesueur's Rat-Kangaroo."

The striped Bandicoot, *Perameles bougainvillei*, was reported some years ago by Mr. Shortridge as extinct. Fortunately this is not the case, for I was able to get twelve good specimens.

The Mouse, *Pseudomys (Gyomys) albocinereus squalorum*, is plentiful. It has a beautiful soft whitish-grey fur, white feet and tail.

The only other mammals were Bats, but as it was so early in the summer I only saw two or three, of which, thanks to Mr. Sheriefs I was able to obtain one *Nyctinomus planiceps*, Peters.

The nesting season of the eagles and ospreys was well advanced. On Dorré Island I located three nests of *Haliaetus leucogaster*, the white-bellied Sea Eagle. One contained eggs, and the other two fledgelings; while there were ten or more nests of *Pandion leucocephalus*, the white-headed Osprey. Owing to the rocky nature

of the country, the nests are difficult of access. One sea eagle's nest (Plate xiv., figs. 1 and 2) found on the east coast contained two eggs. It was a very bulky structure, the diameter on the top being 183 c.m., at base 240, height 52; the mould was only 65 wide by 12 deep. To reach the nest it was necessary to make a detour of at least a quarter of a mile to find a spot where one could climb down to the shore, about 40 feet below. Both eggs were slightly incubated. Two other nests of this eagle which I found on August 27th, contained young birds at least a fortnight old. On August 20th, during an excursion southwards, I found eight nests of the Osprey, of which several were old and deserted. It is more plentiful than the Sea-eagle, for five of these fine birds were in sight at once. A nest visited on August 7th was on a projecting cliff, and contained three young, two about a fortnight old, and the other about a week. It measured across the top 141cm., base 160cm., mould 59cm., depth of same 6cm., height of nest 88cm. Both parent birds and their young were secured (Plate xv.)

A remarkable find on this island was the nest with two young of *Uroaetus audax* (Plate xvi.), for owing to the total absence of trees, it was built on the side of a hill to secure a good outlook. It was situated about 15 yards from the top of the hill, and 35 from the foot. Across the top the nest measured 196 cm., at bottom 244 cm. The height on the upper side, top, was 53cm., and on the lower, 260cm.

Besides eagles, there were large colonies of Cormorants, Sea-gulls and Terns; these had quite finished their nesting.

The breeding season of the smaller birds, *Malurus*, *Sevicornis*, *Megalurus*, etc., had finished about the end of May. They were always to be found in family groups of two old and three or four young birds. These were not common, for one often tramped mile after mile without seeing a single bird.

Bernier Island has the same desolate appearance as Dorré, perhaps even worse, as there are no flowers and the scrub is thicker. To travel a mile and a half per hour may be considered good work, and even that is very tiring.

The animal life is nearly the same as on Dorré Island, with the exception of *Megalurus*, which is not to be found here, and the Eagles and Ospreys are not so numerous as on Dorré Island. I

found only one nest of *Haliaetus leucogaster* and four of *Pandion leucocephalus*. On the north end Knock's Island, numbers of Terns, both *Sterna bergii* and *S. nereis* had been breeding. The Cormorants had no breeding place.

As will be seen from the list appended, I secured a very good collection, and I desire to place on record my sincere thanks to Dr. Lovegrove and to Mr. Sheriefs for the valuable assistance they gave me.

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LIST OF BIRDS OBSERVED ON DORRE<sup>1</sup>  
AND BERNIER ISLANDS.

BY

O. LIPFERT, September, 1910.

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<i>Puffinus chlororhynchus</i>	...	B.	Seen flying around steamer on returning to Carnarvon.
<i>Sterna bergii</i>	...	D.B. br.	(young, fully fledged on 17th Sept.)
<i>Sterna nereis</i>	...	D.B. br.	do.
<i>Larus novae-hollandiae</i>	...	D.B. br.	
<i>Gabianus pacificus</i>	...	D.B. br.	
<i>Arenaria interpres</i>	...	B.	
<i>Haematopus longirostris</i>	...	D.B. br.	
<i>Haematopus fuliginosus</i>	...	D.B. br.	
<i>Charadrius dominicus</i>	...	B.	
<i>Peltohyas australis</i>	...	B.	
<i>Numenius cyanopus</i>	...	B.	Visitor (seen by Dr. Lovegrove).
<i>Limonites (Pisobia) ruficollis</i>	...	B.	
<i>Eupodotis australis</i>	...	B.	Visitor only.
<i>Demigretta sacra</i>	...	D.B. br.	
<i>Phalacrocorax hypoleucus</i>	...	D.B. br.	Large colony on Dorré Island.
<i>Circus assimilis</i>	...	D.	Only seen once near S. end.
<i>Uroaetus (Aquila) audax</i>	...	D. br.	
<i>Haliaetus leucogaster</i>	...	D.B. br.	
<i>Cerchueis cenehroides</i>	...	D.B.	
<i>Pandion leucocephalus</i>	...	D.B. br.	



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<i>Podargus</i> sp ?	...	B. Only seen once on W. coast.
<i>Cypselus pacificus</i>	...	B. Visitor during April, May and June.
<i>Hirundo neoxena</i>	...	D.B. br.
<i>Megalurys striatus</i>	...	D.
<i>Sericornis maculata</i>	...	D.B.
<i>Malurus bernieri</i>	...	D.B.
<i>Zosterops gouldi</i> ...	...	B. Visitor.
<i>Ptilotis sonora</i> ...	...	D.B.
<i>Anthus australis</i> ...	...	D.B.

D.—Dorré Island.

B.—Bernier Island.

br.—Breeding in August and September.

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## MUSEUM NOTES.

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### THE TRUSTEES ACT (1 GEO. V., 1911, No. 27).

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The Museum on its establishment in Perth in 1889, was directly under the control of the Hon. the Commissioner of Crown Lands; in 1894 on the appointment of a Minister of Mines, it was transferred to his charge; in 1895 it was placed under the control of a Committee of eight gentlemen nominated by the Government.

On the 16th February, 1911, assent was given to:—"An Act to provide for the appointment and incorporation of Trustees for the Public Library of Western Australia, and the Western Australian Museum and Art Gallery, and for purposes consequent on and incidental to that object."

This Act came into operation on the 20th November, 1911, by Proclamation of His Excellency the Governor, Sir Gerald Strickland, K.C.M.G. (Gov. Gazette No. 63, 10th November, 1911). At the same time the Governor in Executive Council nominated twelve Trustees, of whom seven, the Hon. Henry Briggs, M.L.C.; M. F. A. Canning, Esq.; Hon. Sir J. Winthrop Hackett, Kt., M.L.C., etc.; Dr. H. F. Harvey; Dr. H. T. Kelsall; The Hon. Mr. Justice McMillan; and the Rt. Rev. Dr. Riley had been members of the Committee; the remaining five are F. W. Burrows, Esq.; Walter Dwyer, Esq., M.L.A.; R. S. Haynes, Esq., K.C.; Sir Walter James, Kt., K.C.; and H. S. King, Esq.

On the 24th November, these Trustees met for the co-optation of two Trustees under Clause IV. of the Act, when the Hon. Sir Edward A. Stone, K.C.M.G., and W. Somerville, Esq., were nominated.

On the 27th November, the Hon. Sir J. Winthrop Hackett, Kt., M.L.C., M.A., LL.D., *Officier de l'Académie Française*, was elected President of the Board.

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C. G. Morris, Esq., of the Lands Department has been appointed a Trustee in place of the late Mr. M. F. A. Canning.

## RECENT ADDITIONS TO THE COLLECTIONS.

SCULPTURE.—A cast of the Monasterboice Cross received in exchange from the National Museum, Dublin. The Laocoon presented by the Hon. Sir J. Winthrop Hackett, and Augustus Cæsar purchased.

PAINTINGS.—An Australian Landscape "Summer," Gumeracha, S.A., 1910-11, by Will Ashton of Adelaide, purchased by the Committee aided by public subscription. "Love under the Rose," by Francesco Vineo of Florence, purchased on the recommendation of Sir J. D. Linton, P.R.I.; "Idleness," by Rupert C. W. Bunny; this and four water colours, "The Nursery," by Sir E. Waterlow, R.A., P.R.W.S.; "Old Harbour, Genoa," by J. McWhirter, R.A.; "A Windy Day," by J. W. Herald, and "Mauve and Greys," by Francis E. James, A.R.W.S., were presented by the President, the Hon. Sir J. Winthrop Hackett, M.L.C., etc.

ANTIQUITIES.—Repliquas of the Vaphio Bull Cups, of Bronze Daggers, and gold tiara and plaques of Aegean (Mycenean) origin.

ZOOLOGY.—A specimen of *Notoryctes typhlops*, the Marsupial Mole from Wollal on the 90-Mile Beach, on the North-west Coast, was presented by Mr. S. J. Pryon; this is the second obtained in this State, the first being found at Joanna Springs, about midway between Wollal and the South Australian border. Skins of a kangaroo collected by Mr. J. P. Rogers in the McClintock Range, South-east Kimberley, in 1909, were sent to Mr. Oldfield Thomas, who in the "Annals and Magazine of Natural History," June, 1911, described them as a new sub-species of Wallaroo under the name of *Macropus robustus bracteator*. The fur is longer and darker than that of *M. v. woodwardi* from Grant Range, West Kimberley. Mr. Rogers at the same time obtained an example of *Phascogale penicillata pirata*, not hitherto known to occur in this State.

REPTILIA —Descriptions of some new species will be published in Part III.

FREE POPULAR LECTURES ON SCIENCE AND ART.—The Eighth Series will be opened on Friday the 26th April next. These Lectures are attracting larger audiences every year, and it is hoped that the Government will provide a Lecture-room in the near future, for at present the Art Gallery has to be used for that purpose.

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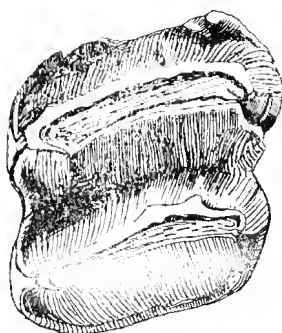


Fig 8.

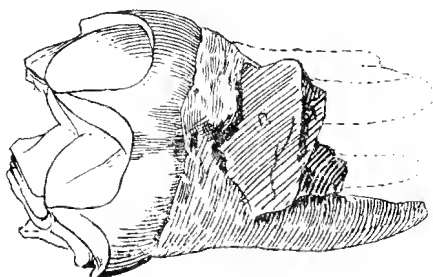


Fig 9

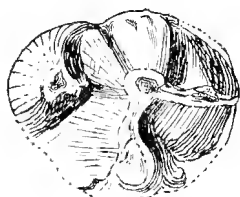


Fig 10



*Nototherium*, sp.

Fig. 8—Working surface of left upper molar.

Fig. 9—Outer aspect of same tooth.

Fig. 10—Working surface of left upper premolar.



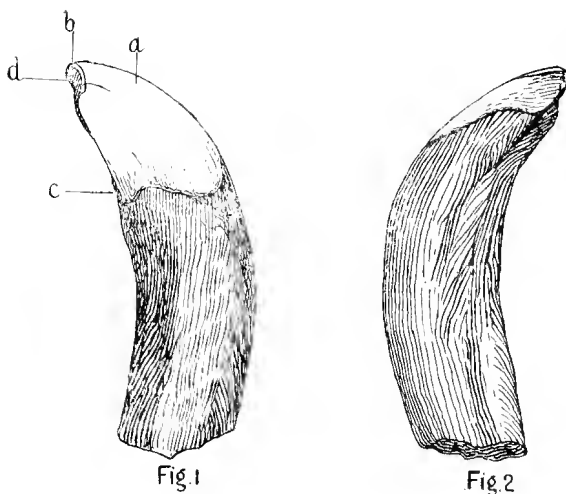


Fig. 1

Fig. 2

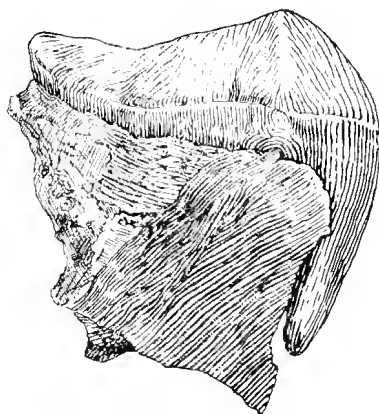


Fig. 3



*Thylacoleo*, sp.

Fig. 1—Outer aspect of left upper incisor.

Fig. 2—Inner aspect of same.

Fig. 3—Outer aspect of left upper functional premolar.

*a* Unworn enamel.

*c* Unworn dentine.

*b* Worn enamel.

*d* Exposed and worn dentine.





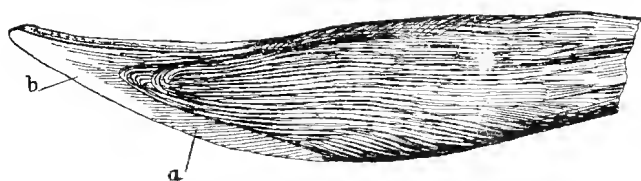


Fig. 4

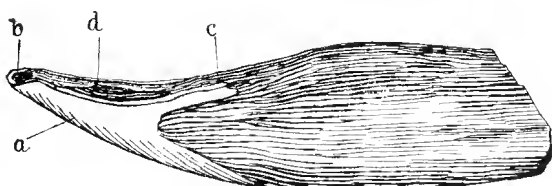


Fig. 5

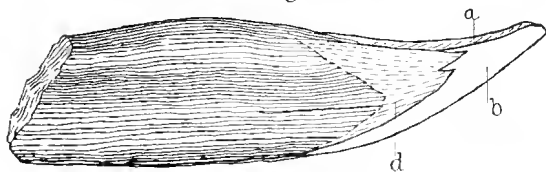


Fig. 6

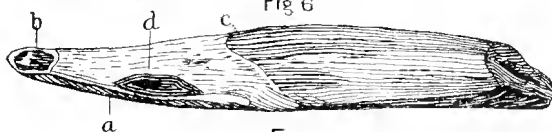


Fig. 7



*Thylacoleo*, sp.

Fig. 4—Inner aspect of right lower incisor showing the polished and scratched enamel at *b*.

Fig. 5—Outer aspect of left lower incisor.

Fig. 6—Inner aspect of same showing the large area of worn enamel at *b*.

Fig. 7—Upper view of the same tooth

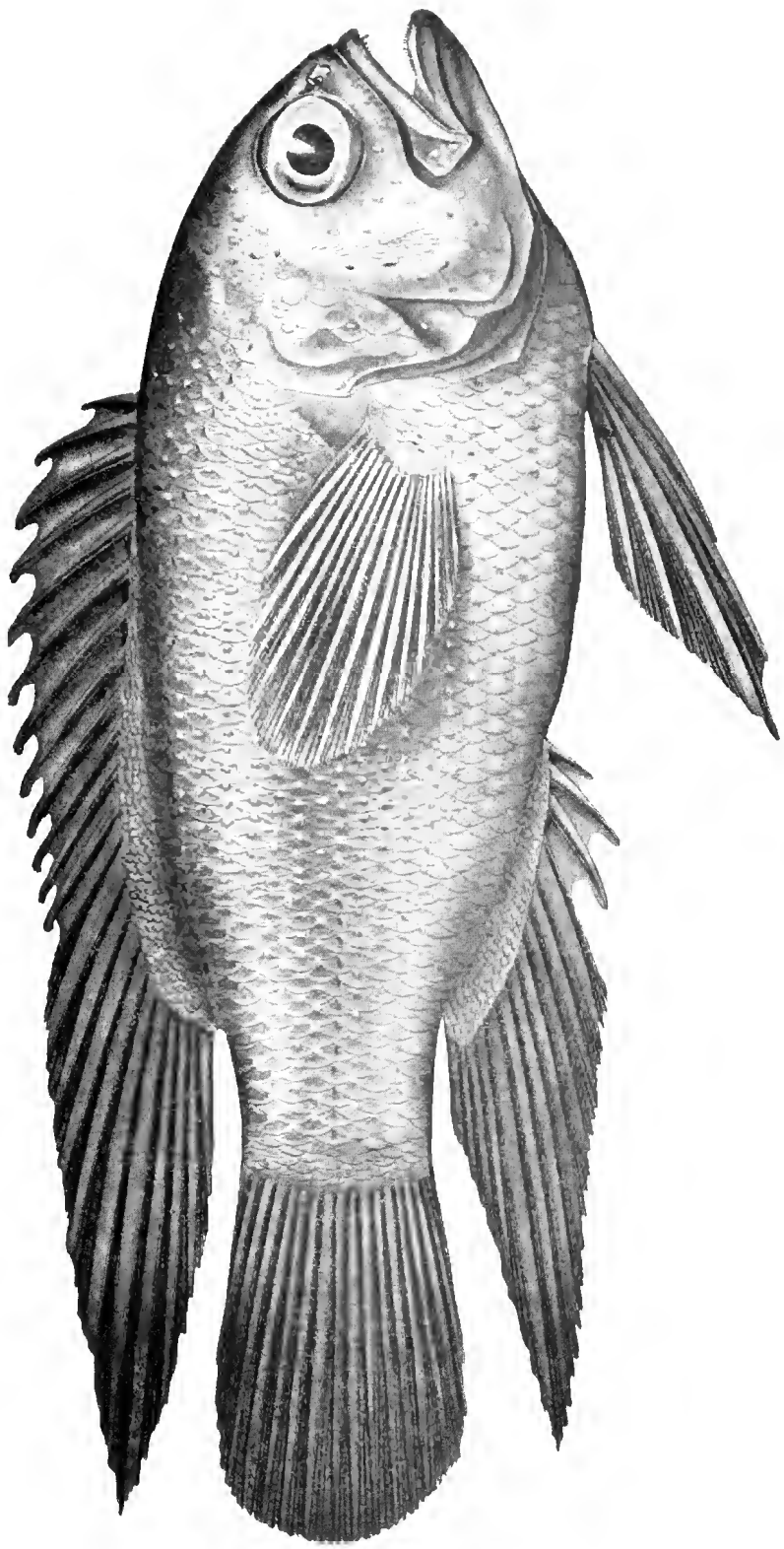
*a* Unworn enamel.

*c* Unworn dentine.

*b* Worn enamel.

*d* Exposed and worn dentine.

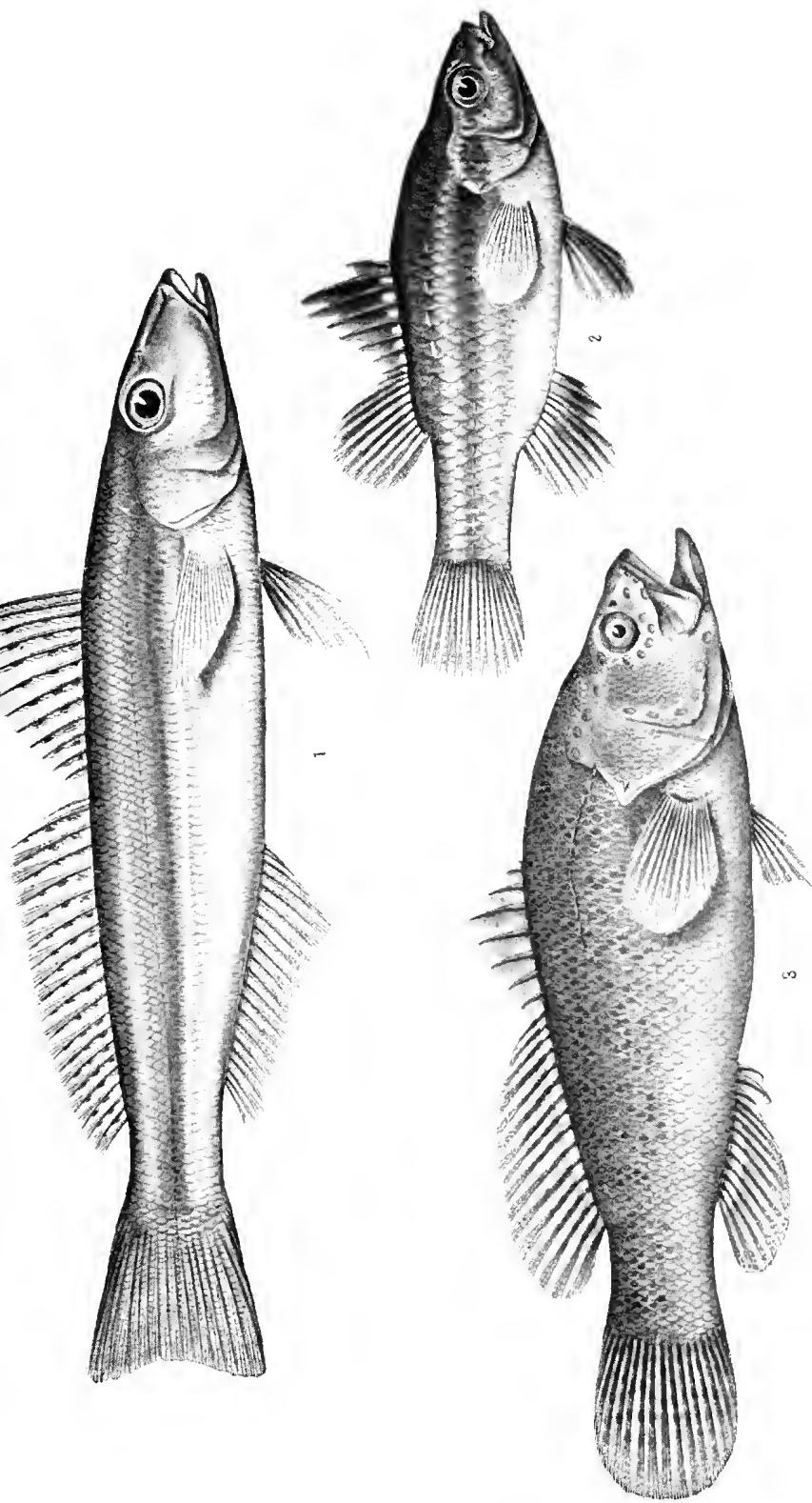




A. R. McCulloch, *del.*]

*Paraplesiops melanogris*, Peters.  
PLATE IX

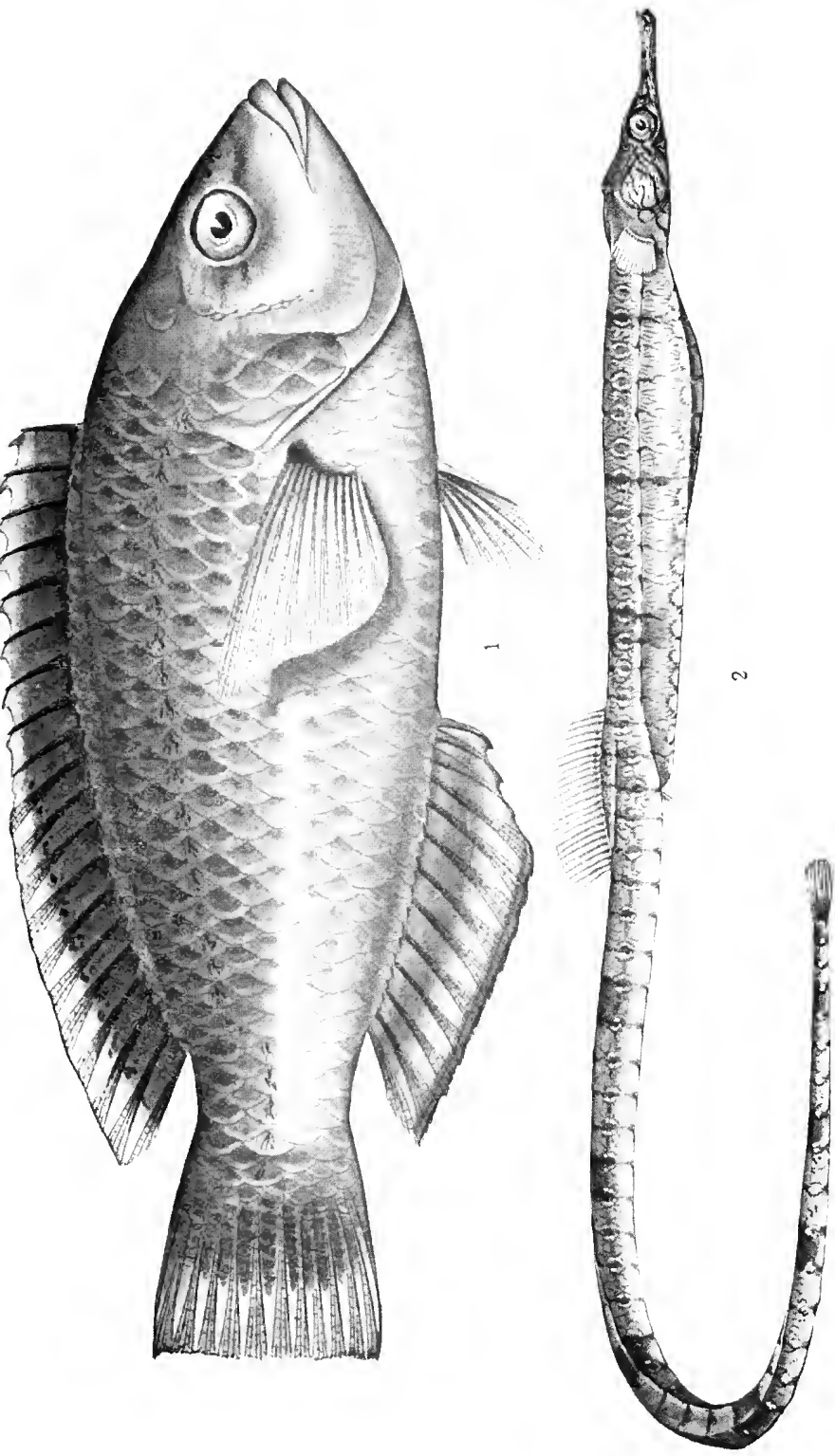




A. R. McCulloch, *del.*]

Fig. 1—*Sillago bostockii*, Castlenau  
 Fig. 2—*Eddia vittata*, Castlenau.  
 Fig. 3—*Bostockia hemigramma*, Ogilby.



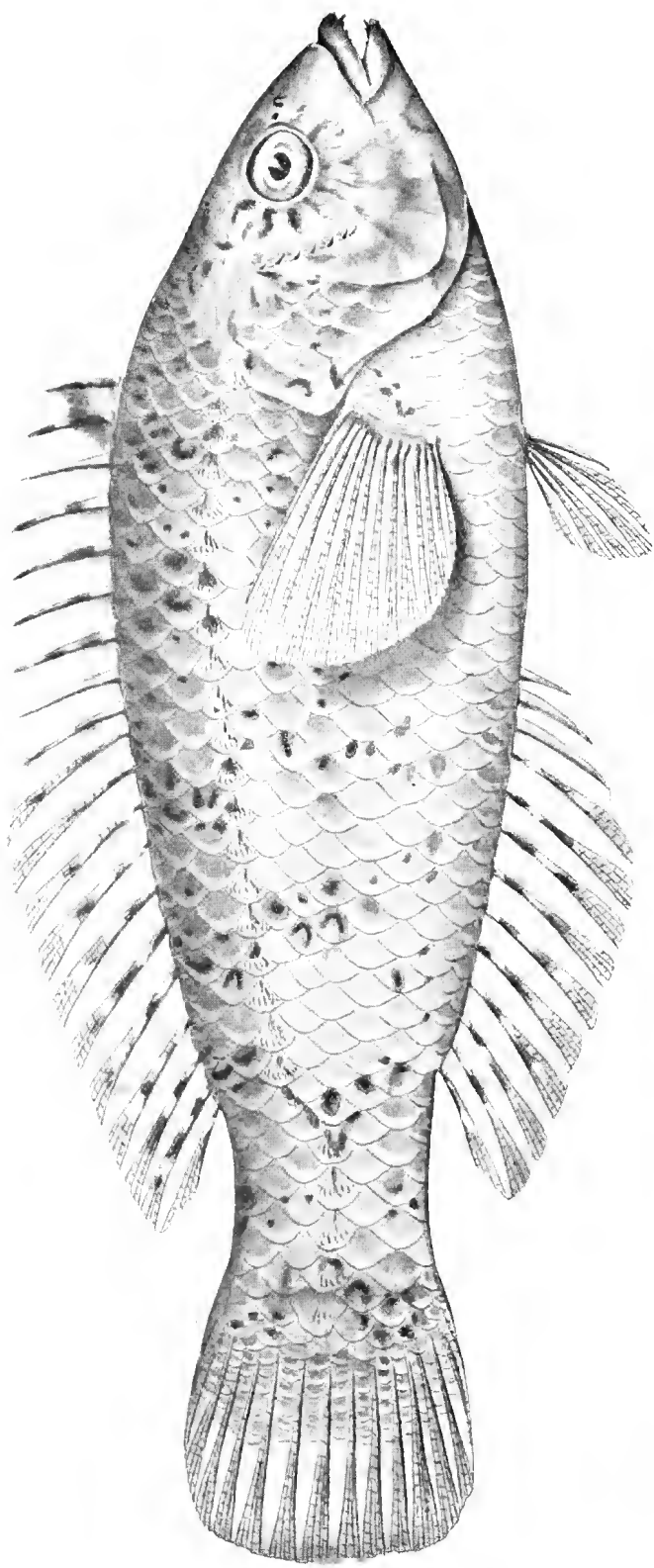


A. R. McCulloch, *del* ]

Fig. 1—*Pseudolabrus hotokeii*, Castlenau.  
Fig. 2—*Syngnathus tigris*, Castlenau.





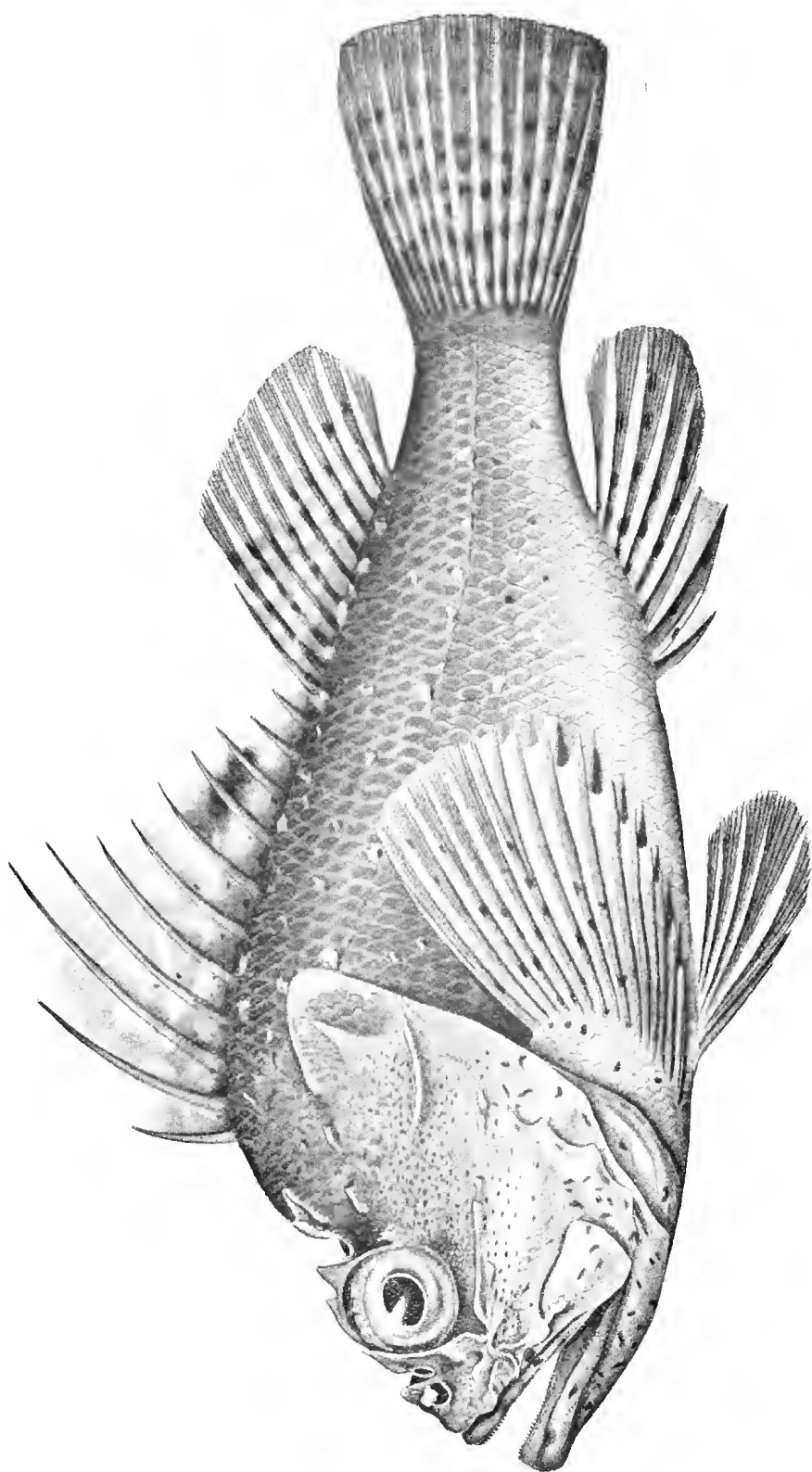


A. R. McCulloch, *del.*]

*Pseudolabrus parilus*, Richardson.

PLATE XII.





A. R. McCulloch, del.]

*Scorpaena sumptuosa*, Castlenau.

PLATE XIII.



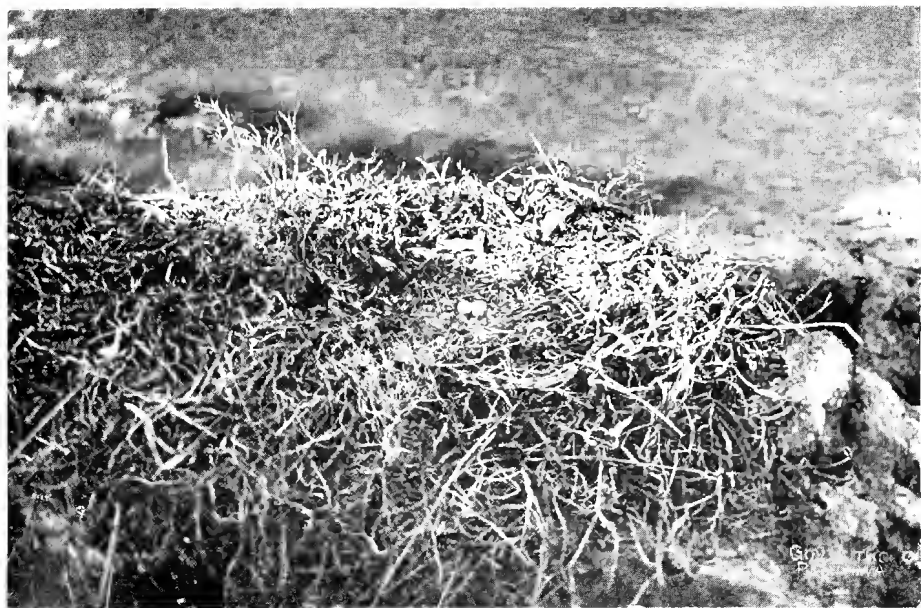


FIG. 1 Nest and Eggs of the White-bellied Sea Eagle.



FIG. 2—Distant view of the same Nest, its position is indicated by the white cross  
*Haliaeetus leucogaster*.





*Pandion leucocephalus.*  
Nest of the White-headed Osprey.  
PLATE XV.







*Uroaetus (aquila) audax.*  
Nest and two young of the Wedge-tailed Eagle





# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM AND ART GALLERY

EDITED BY THE DIRECTOR,  
BERNARD H. WOODWARD, F.G.S., C.M.Z.S.

## VOLUME I. PART III.

### CONTENTS.

	PAGE
W. A. Echinoderms, by W. B. Alexander, M.A. - - -	105
The Crinoids collected by the <i>Endeavour</i> between Fremantle and Geraldton, by Austin Hobart Clark - - -	113
The Echinoderms of the W. A. Museum, by Hubert Lyman Clark, Pb.D. - - -	132
On a Collection of Reptiles and Batrachians from W. A., by Dene B. Fry - - -	174
Notes on some W. A. Fish, by Allan R. McCulloch - - -	211
Revision of the Freshwater Crayfishes of South Western Australia, by Allan R. McCulloch - - -	228
On a Specimen of <i>Regalecus glesne</i> , Ascan., obtained in W. A., by W. B. Alexander, M.A. - - -	236
A Brachiopod New to Australian Waters, by W. B. Alexander, M.A. - - -	239
A New Species of Embiid from W. A., by Dr. K. Friederichs -	241
The Mammoth Cave (Continued), by L. Glauert, F.G.S. -	244
Further Important Discoveries in the Mammoth Cave, by the Editor - - -	252

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## WESTERN AUSTRALIAN ECHINODERMS

BY

W. B. ALEXANDER, M.A.

In the two papers which follow (Crinoids, by A. H. Clark, and Echinoderms, by H. L. Clark) will be found descriptions of most of the Echinoderms in the Western Australian Museum. To prevent any misunderstanding it seems necessary to mention the circumstances under which the papers were written.

During June, 1912, the F.I.S. *Endeavour* was engaged in trawling operations off the Western Australian coast between Fremantle and Geraldton, and the Director obtained permission from the Federal authorities for the writer to accompany her on two of her trips to obtain specimens for this Museum.

Perhaps the most striking feature of the hauls made by the *Endeavour* was the very large number of Crinoids which were brought up on many occasions. In number of individuals they surpassed all the other groups of Echinoderms put together. In view of the fact that Mr. Austin H. Clark, of Washington, had recently published a paper on the Crinoids of Australia, the collection was sent to him for identification, and his report on this collection constitutes the first of the papers which follow.

In the meantime, Mr. H. Lyman Clark, of Harvard, had offered to determine the Echinoderms already in the Museum, and the remainder of the Echinoderms including all those obtained by the *Endeavour*, except the Crinoids, were therefore sent to him. A few species which had been named by the authorities of the Australian Museum in Sydney, and a few of the *Endeavour* specimens of the same species, together with some Crinoids which had previously been identified by Mr. A. H. Clark, along with those collected by the Hamburg Expedition, were not sent away.

In the introduction to his paper dealing with this material Mr. Clark drew a number of conclusions as to the relative proportions

in which the different orders were represented in Western Australian waters. As, however, the numbers he used were vitiated by the assumption that he had the whole of the Museum collection before him, with his permission the numbers have been removed from the paper as written by him and the true totals set out in this place.

It seems better to consider the collection in two portions. The first of these has been slowly accumulating for a number of years and is composed of specimens found on the shore in various parts of the State and on the reefs of the Abrolhos Islands. Excluding specimens too imperfect for complete identification, 46 species are represented distributed among the different classes thus: Crinoids 7, Asteroids 16, Ophiurans 2, Echini 15, Holothurians 6.

The second portion of the collection consists of the specimens trawled by the *Endeavour* in depths varying from 19 to 120 fathoms, on the slope of the Continental shelf; most of these come from a depth of more than 50 fathoms. It contains 36 species distributed thus: Crinoids 12, Asteroids 7, Ophiurans 10, Echini 7. Only 7 species are represented in both portions of the collection.

It is doubtful whether these numbers give a true idea of the real proportions in which the classes occur in Western Australian waters. The first portion of the collection is evidently a selected one, the larger and more striking Echini and Asteroids predominate. Holothurians have a commercial interest, whilst some of the Crinoids are very beautifully coloured. The Ophiurans, which are mostly small and fragile, do not appeal to the ordinary individual for any of these reasons and are unrepresented.

The collection which was made on board the *Endeavour* probably approximates much more closely to the true proportions existing amongst the forms found in deeper water, on a sandy bottom, though it is probable that here again the larger forms predominate unduly, as a trawl is not the best instrument with which to collect small and fragile specimens.

The following table will give an idea of the comparison between these collections and that made by the *Thetis* on the coast of New South Wales.

	Collection in W.A. Museum.	<i>Endeavour</i> Collection from W. Australia.	<i>Thetis</i> Collection from New South Wales	Percentage of recent Species known in each Class
Crinoids ...	7	12	3	11
Asteroids ...	16	7	9	25
Ophiurans ...	2	10	18	34
Echini ...	15	7	15	12
Holothurians	6	—	8	18
Totals ...	46	36	53	100

As far as they go these figures seem to prove that on both the Western and Eastern coasts of Australia Echini are unusually numerous, while the number of Crinoids found in Western Australia is a long way above the normal.

A list of all the identified Echinoderms in the Museum, with their localities when known, is attached. In addition to the sources already referred to, Dr. Michaelsen has presented a number of Ophiurans and Crinoids collected in this State by the Hamburg Expedition in 1905. These are included in the list.

[The Classification followed is that of Bronn's "Tier-reichs" for all the groups except the Crinoids. The later class are arranged according to Mr. A. H. Clark's Monograph of the Recent Crinoids of Australia.]

# WESTERN AUSTRALIAN ECHINODERMATA

## IN THE WESTERN AUSTRALIAN MUSEUM.

### Class CRINOIDEA (SEA LILIES, FEATHER STARS).

#### Order COMATULIDA.

##### Family COMASTERIDAE.

<i>Capillaster sentosa</i> , Carp.	Between Fremantle and Geraldton.
<i>Capillaster multiradiata</i> , Linn.	" " "
<i>Comatulella brachiolata</i> , Lamk.	" " "
<i>Comatula purpurea</i> , Müll.	" " "
<i>Comatula solaris</i> , Lamk.	_____
<i>Comanthus alternans</i> , Carp.	Abrolhos Islands.
<i>Comanthus belli</i> , Carp.	Port Hedland.
<i>Comanthus annulata</i> , Bell,	Between Fremantle and Geraldton.
<i>Comanthus parvicirra</i> , Müll.	" " "
<i>Comanthus polycnemis</i> , A. H. Clark	_____

##### Family ZYGOMETRIDAE.

<i>Zygometra elegans</i> , Bell.	Between Fremantle and Geraldton.
----------------------------------	----------------------------------

##### Family HIMEROMETRIDAE.

<i>Amphimetra discoidea</i> , A. H. Clark.	Between Fremantle and Geraldton
--	---------------------------------

##### Family MARIAMETRIDAE.

<i>Dichrometra pygma</i> , Bell.	Inner Bar, Shark Bay.
----------------------------------	-----------------------

##### Family TRIPIOMETRIDAE.

<i>Tropiometra afra</i> , Hartl.	Between Fremantle and Geraldton.
----------------------------------	----------------------------------

##### Family CALOMETRIDAE.

<i>Neometra gorgonia</i> , A. H. Clark.	Between Fremantle and Geraldton.
<i>Neometra conaminis</i> , A. H. Clark.	" " "

##### Family THALASSOMETRIDAE.

<i>Ptilometra macronema</i> , Müll.	Off Geraldton.
-------------------------------------	----------------



## Class ASTEROIDEA (STAR FISHES.)

## Order PHANEROZONIA.

## Family ASTROPECTINIDAE.

- Astropecten triseriatus*, Müll & Trosch. Garden Island.  
*Lindiamaculata*, Müll & Trosch. Between Fremantle and Geraldton.

## Family PENTAGONASTERIDAE.

- Pentagonaster stibarius*, H. L. Clark. Between Fremantle and Geraldton.  
*Tosia australis*, Gray. Fremantle.  
*Iconaster longimanus*, Möbius Broome.  
*Nectria ocellifera*, Lamk. Between Fremantle and Geraldton.  
*Stellaster inaei*, Gray. Carnac Island. Between Fremantle and Geraldton.  
*Stellaster megaloprepes*, H. L. Clark. Port Hedland.

## Family ANTHENEIDAE.

- Anthenea tuberculosa*, Gray. \_\_\_\_\_

## Family PENTACEROTIDAE.

- Oreaster gracilis*, Lütken. \_\_\_\_\_  
*Oreaster nodulosus*, Perrier. \_\_\_\_\_  
*Culcitaster anamesus*, H. L. Clark. \_\_\_\_\_

## Family ASTERINIDAE.

- Nepanthia brevis*, Perrier. Fremantle, Cottesloe.  
*Anseropoda rosacea*, Lamk. Port Hedland.  
*Asterina gunnii*, Gray. Fremantle, Cottesloe.

## Order CRYPTOZONIA.

## Family LINCKIIDAE.

- Linckia tyloplax*, H. L. Clark. Between Fremantle and Geraldton.

## Family ECHINASTERIDAE.

- Echinaster arcystatus*, H. L. Clark. Between Fremantle and Geraldton.  
*Echinaster purpureus*, Gray. Fremantle, Broome.  
*Echinaster vestitus*, Perrier? Port Hedland.  
*Plectaster decanus*, Müll & Trosch. Albany.

## Family ASTERIIDAE.

*Asterias polyplax*, Müll & Trosch. Between Fremantle and Geraldton.*Asterias calamaria*, Gray. ———

## Class OPHIUROIDEA (BRITTLE STARS).

## Order ZYGOPHIURAE.

## Family OPHIODERMATIDAE.

*Pectinura discryta*, H. L. Clark. Between Fremantle and Geraldton.

## Family AMPHIURIDAE.

*Ophiactis savignyi*, M.T. Freycinet Estuary, Shark Bay.*Amphiura constricta*, Lym. Champion Bay, Geraldton.*Amphiura squamata*, Chiaje. Oyster Harbour, Albany.

## Family OPHIACANTHIDAE.

*Ophiacantha clavigera*, Kochler. Koombana Bay, Bunbury.

## Family OPHIOCOMIDAE.

*Ophiocoma brevipes*, Peters. Shark Bay.*Clavigera wendti*, M.T. Shark Bay.

## Family OPHIOTRICHIDAE.

*Ophiothrix stelligera*, Lym. Cockburn Sound, Fremantle.  
Between Fremantle and Geraldton.*Ophiothrix spongicola*, Stimpson. Between Fremantle and Geraldton.*Ophiothrix hirsuta*, M.T. Freycinet Reach, Shark Bay.*Ophiothrix longipeda*, Lamk. Abrolhos Islands.*Ophiothrix hartmeyeri*, Kochler. Sunday Island, Shark Bay.*Ophiothela danae*, Verrill. Surf Point, Shark Bay.

## Order STREPTOPHIURAE.

## Family OPHIOMYXIDAE.

*Ophiomyxa australis*, Lütke. Between Fremantle and Geraldton.

## Order CLADOPHIURAE.

## Family ASTROPHYTIDAE.

*Astrogymnotes catasticta*, H. L.

Clark.

Off Jurien Bay.

<i>Ophiocreas melambaphes</i> , H. L.	
Clark.	Off Jurien Bay.
<i>Ophiocreas rhabdotum</i> , H. L.	
Clark.	Off Jurien Bay.
<i>Conocladus microcomus</i> , H. L.	
Clark.	Between Fremantle and Geraldton.
<i>Astroboa ernae</i> , Död.	Off Geraldton.
<i>Euryale aspera</i> , Lamk.	Off Geraldton.

## Class ECHINOIDEA (SEA URCHINS).

## Order CIDAROIDA.

## Family CIDARIDAE.

<i>Tretocidaris bracteata</i> , A. Ag.	Between Fremantle and Geraldton.
<i>Goniocidaris tubaria</i> , Lamk.	„ „ „
<i>Phyllacanthus annulifera</i> , Lamk.	Port Hedland.
<i>Phyllacanthus magnificus</i> , H. L.	
Clark.	Between Fremantle and Geraldton.

## Order DIADEMATOIDA.

## Family DIADEMATIDAE.

<i>Centrostephanus tenuispinus</i> , H.	
L. Clark.	Between Fremantle and Geraldton.

## Family TEMNOPLEURIDAE.

<i>Salmacis alexandri</i> , Bell.	Off Geraldton.
<i>Salmacis sphaeroides</i> , Linn.	Port Hedland.
<i>Salmacis bicolor</i> , Ag.	_____
<i>Amblypneustes griseus</i> , Blainv.	Fremantle.
<i>Amblypneustes grandis</i> , H. L.	
Clark.	Between Fremantle and Geraldton.
<i>Holopneustes porosissimus</i> , Ag.	Fremantle.
<i>Holopneustes purpurescens</i> , A. Ag.	_____

## Family ECHINOMETRIDAE.

<i>Helicoidaris armigera</i> , A. Ag.	Fremantle, Cottesloe.
<i>Helicoidaris erythrogramma</i> , Val.	_____
<i>Echinometra mathaei</i> , Blainv.	_____

## Order CLYPEASTROIDA.

## Family CLYPEASTRIDAE.

*Clypeaster telurus*, H. L. Clark. Between Fremantle and Geraldton.

## Family LAGANIDAE.

*Laganum peroni*, Ag. Swan River.

*Peronella aphnostina*, H. L.

Clark. Carnac Island.

## Order SPATANGOIDA.

## Family SPATANGIDAE.

*Linthia australis*, Gray. Fremantle, Cottesloe.

*Echinocardium australe*, Gray. Safety Bay.

*Brynia australasiae*, Leach. Abrolhos Islands, Broome.

Class HOLOTHURIOIDEA (SEA CUCUMBERS,  
BECHE-DE-MER).

## Order ACTINOPODA.

## Family ASPIDOCHIROTAE.

*Actinopyga miliaris*, Q. & G. \_\_\_\_\_

*Holothuria atra*, Jaeger. \_\_\_\_\_

## Family DENDROCHIROTAE.

*Colochirus axiologus*, H. L. Clark. Port Hedland.

*Colochirus quadrangularis*, Less. \_\_\_\_\_

*Colochirus tuberculosus*, Q. & G. \_\_\_\_\_

## Family MOLPADIIDAE.

*Caudina tetrapora*, H. L. Clark. Cottesloe Beach.

# THE CRINOIDS

COLLECTED BY THE *ENDEAVOUR* BETWEEN  
FREMANTLE AND GERALDTON  
(WESTERN AUSTRALIA).

By AUSTIN HOBART CLARK.

---

## PREFACE.

Mr. Bernard H. Woodward, the Director of the Western Australian Museum and Art Gallery at Perth has recently honoured me with a request to examine a collection of comatulids or unstalked crinoids brought together by the *Endeavour* while working along the coast of Western Australia between Fremantle and Geraldton.

Mr. Wilfrid B. Alexander accompanied the *Endeavour* at the time the collection described herein was made, taking careful colour notes on many of the specimens. These he has been kind enough to permit me to incorporate herein.

Within the past two years the Australian crinoid fauna has received a considerable amount of attention; in 1911 there was published at Sydney a comprehensive monograph on the crinoids of Australia, including a historical introduction, a complete synonymy and a bibliography; every Australian record of a crinoid or of a supposed crinoid is given. At the same time there was published a memoir upon the crinoid fauna of Australia west of 140°E. long., based upon the collection made by the Hamburg West Australian Expedition under Drs. W. Michaelsen and R. Hartmeyer in 1905. In this memoir every record of a crinoid in the region under consideration is included, and the faunas of the various coasts of the continent are compared. In 1912 a paper on the crinoids preserved in the Naturhistorisches Museum, at Hamburg, appeared in which the following new records were included: *Comaster belli*, from Houtman's Rocks; *Comanthus samoanu*

(not previously known from Australia), from Houtman's Rocks; and *Petasometra helianthoides* (gen. et. sp. nov.) from Shark Bay; other species were listed from localities where they were already known to occur, or from localities within their ascertained range. In another paper a new species of *Zygometra*, *Z. punctata*, was described from the Aru Islands where it had been collected by the *Siboga*, and at the same time was recorded from Port Curtis, Queensland, and from Holothuria Bank in north-western Australia. In 1913 a supplement to the memoir on the crinoids of south-western Australia was published in which some additional specimens collected by Drs. Michaelsen and Hartmeyer were recorded and the information regarding the crinoid fauna of this region was brought up-to-date.

---

## THE ENDEAVOUR COLLECTION.

The present collection contains representatives of twelve species included in nine genera and eight families and sub-families, as follows:—

### Family: COMASTERIDAE.

#### Sub-family: CAPILLASTERINAE.

*Capillaster sentosa* (P. H. Carpenter).

*Capillaster multiradiata* (Linné).

#### Sub-family: COMACTINIINAE.

*Comatulella brachiolata* (Lamarck).

*Comatula purpurea* (J. Müller).

#### Sub-family: COMASTERINAE.

*Comanthus (Vania) annulata* (Bell).

*Comanthus (Vania) parvicirra* (J. Müller).

### Family: ZYGOMETRIDAE.

*Zygometra elegans* (Bell).

### Family: HIMEROMETRIDAE.

*Amphimetra discoidea* (A. H. Clark).

### Family: TROPIOMETRIDAE.

*Tropiometra afra* (Hartlaub).

## Family : CALOMETRIDAE.

*Neometra gorgonia*, sp. nov.*Neometra conaminis*, sp. nov.

## Family : THALASSOMETRIDAE.

*Ptilometra macronema* (J. Müller).

These species fall naturally into the following classes :—

## EAST INDIAN SPECIES.

*Capillaster sentosa*. *Comanthus annulata*.*Capillaster multiradiata*. *Comanthus parvicirra*.

## AUSTRALIAN TROPICAL SPECIES.

*Comatula purpurea*. *Tropiometra afra*.*Zygometra elegans*. ? *Neometra gorgonia*.*Amphimetra discoidea*. ? *Neometra conaminis*.

## SOUTH AUSTRALIAN SPECIES.

*Comatulella brachiolata*. *Ptilometra macronema*.

The family Calometridae was not previously known to occur on the Australian coasts, though it was to be expected that it would be discovered as soon as dredging operations were carried into sufficiently deep water.

*Capillaster sentosa* also is new to the Australian coasts, though in view of its wide range in the East Indian region its presence here is not surprising.

*Tropiometra afra*, though only known from Australia, has been previously reported only from Bowen, Queensland ; its occurrence on the west coast, and so far to the southward is therefore a matter of considerable interest.

The known range of *Capillaster multiradiata* has been extended southward from Dirk Hartog Island, and the occurrence of *Comatulella brachiolata*, *Comatula purpurea*, *Comanthus annulata*, *Zygometra elegans* and *Amphimetra discoidea* in the vicinity of Perth, about which there had previously been some question, has been established.

## DESCRIPTION OF SPECIES COLLECTED.

Fam.: COMASTERIDAE, A. H. Clark.

Sub-fam.: CAPILLASTERINAE, A. H. Clark.

Genus: CAPILLASTER, A. H. Clark.

## CAPILLASTER SENTOSA, P. H. Carpenter.

*Comatula multiradiata* (part) 1816. Lamarck, Hist. nat. des animaux sans vertèbres, vol. 2, p. 533.

*Comatula (Alecto) multiradiata* (part) 1849. J. Müller, Abhandl. d.k. preuss. Akad. d. Wiss. (1847), p. 261.

*Actinometra sentosa*, 1888. P. H. Carpenter, *Challenger Reports*, vol. 26, Zoology, p. 325, pl. lxvi., figs. 4-6.

*Capillaster sentosa*, 1912. A. H. Clark, *The Crinoids of the Indian Ocean*, p. 73.

**Differential Characters.** *Capillaster sentosa* has the same curious arm structure as *C. multiradiata*; the IIBr series (the series following the first or "radial" axillary) are 4 (3 + 4), and all the succeeding division series are 3 (2 + 3); the first brachial of the free undivided arms, and the first ossicles following all the axillaries except the first (IBr or "radial" axillary), bear pinnules. It differs from *C. multiradiata* in possessing a much larger centrodorsal, which bears longer and stouter cirri, with between 30 and 40 (commonly about 35) segments, and much more numerous arms, these ranging from thirty to about eighty (most commonly between forty and sixty-five in number).

**Locality.** Between Fremantle and Geraldton.

**Material.** Two specimens; one of these is small, but typical, with seventy-three arms; one of the IIBr series is 2, and the remaining nine are 4 (3 + 4); the following series are all 3 (2 + 3); the other has thirty-three arms 115 mm. long.; there are nine IIBr series, all 4 (3 + 4), and thirteen IIIIBr series, all 3 (2 + 3); the centrodorsal is typically large and hemispherical; the cirri are 27 mm. to 30 mm. long, and are composed of 28-30 segments.

**Distribution.** *Capillaster sentosa* ranges from the Maldive Islands eastward as far as the Philippines and the Moluccas, and southward to south-western Australia.

**Remarks.** This is the first record for this species in Australia, though its occurrence there was to have been expected.



## CAPILLASTER MULTIRADIATA (Linné).

*Capillaster multiradiata*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 736. 1911. A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungsreise, 1905, Bd. 3, Lief. 13, S. 445. 1912. A. H. Clark, The Crinoids of the Indian Ocean, p. 74.

**Locality.** Between Fremantle and Geraldton.

**Material.** Three specimens. One of these has twenty-five arms 110 mm. long; there are eight IIBr. series present, four of them 4 (3+4) and four 2; there are six IIIBr. series, five 3 (2+3) and one 2; there is one IVBr. series of 3 (2+3) following a IIIBr. series of 2; the cirri are XIII, 22+26, 15 mm. to 20 mm. long; the second has twenty-five arms about 100 mm. long; of the ten IIBr. series eight are 4 (3+4) and two are 2; the five IIIBr. series are 3 (2+3); the cirri are XVI, 20+21, 17 mm. long; the third is smaller and broken, but is similar to the others.

**Remarks.** This species has not previously been recorded from further south than Dirk Hartog Island, where the German steamer *Gazelle* dredged it in 7 fathoms.

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Sub-fam.: COMACTINIINAE, A. H. Clark.

Genus: COMATULELLA, A. H. Clark.

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## COMATULELLA BRACHIOLOATA (Lamarck).

*Comatula brachiolata*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 742. 1912. A. H. Clark, The Crinoids of the Indian Ocean, p. 79.

*Comatulella brachiolata*, 1911. A. H. Clark, Ergebnisse der Hamburger sudwest-australischen Forschungsreise, 1905, Bd. 3, Lief. 13, S. 447.

**Locality.** Between Fremantle and Geraldton.

**Material.** One fine specimen; the centrodorsal is thick discoidal, the dorsal pole large, very slightly convex (almost flat), 5 mm. in diameter.

The cirri are XVIII, 35-37 (usually the latter), 15 mm. to 18 mm. long; they are arranged in one (with a partial second) irregular marginal row. All of the component segments are much broader than long. The cirri taper markedly for the first seven segments.

The mouth is radial, situated at the base of the anterior arm pair.

The arms are all of equal length and size, 85 mm. long, 2.5 mm. wide at the base, and 4.3 mm. wide at the broadest place, between the twelfth and fourteenth brachials.

The terminal comb on the proximal pinnules is composed of fifteen teeth which are long and slender, shaped like an arrow head with the point truncated.

All the arms bear ungrooved pinnules in equal numbers. In the proximal portion of the arms the pinnules on either side typically alternate, grooved and ungrooved; further out there are two grooved pinnules between adjacent ungrooved pinnules, and toward the arm tips all the pinnules are grooved.

There is a very great difference in the structure of the grooved and ungrooved pinnules, which is well shown in the more proximal portion of the arm where the two types regularly alternate. The grooved pinnules, after the first two segments, which are rather large, are slender, delicate and very flexible; the ungrooved pinnules have slightly larger basal segments than the grooved and taper very gradually so that they are much stouter than the delicate grooved pinnules; at first they lie horizontally, but in the distal half or third they curve dorsally into the form of a hook or spiral, exactly as do the cirri, forming tendril-like attachments all along the arm whereby the animal fixes each arm securely to the organisms on the sea-floor in addition to fixing its central portion by means of its cirri.

The segments of the stout grooveless pinnules are produced dorsally into blunt rounded processes exactly resembling the dorsal convex swellings on the outer cirrus segments; these are perfectly smooth, with no trace of spines; these processes are entirely absent from the slender grooved pinnules which, instead, bear on the dorsal side of the terminal segments the long recurved spines characteristic of the pinnules of all the species of this family.

The colour in life was purplish red, the centrodorsal and first seven segments of the cirri darker and more brownish, the distal portion of the cirri bright red.

**Remarks.** Morphologically the first two segments of the pinnules are merely atrophied brachials, while the remaining

portion of the pinnules, including the third and succeeding segments is merely a tentacular body process, exactly comparable to the cirri, but carrying ambulacral structures on its ventral side.

Each brachial originates as, and is fundamentally, an axillary; one of the two derivatives from this axillary, after the formation of two ossicles, which are united to each other just as are the paired ossicles in the division series, abruptly ceases its development, while the other continues to increase in size, its basal segment attaining the same diameter as the brachial upon which it rests. The atrophied branch from the original axillary stage of the growing brachial serves as the base from which there extends outward a long tentacular structure with no phylogenetic history, which forms within itself a series of skeletal braces as necessity requires, and which is in every way exactly comparable to a cirrus, which also is a long tentacular structure with no phylogenetic history forming within itself a series of skeletal braces as necessity requires, excepting only that it bears ambulacral structures along its ventral surface.

Since pinnules beyond the second segment are merely elongate tentacular processes in which a skeleton is formed as needed, and cirri are also elongate tentacular processes in which a skeleton is formed as needed, it necessarily follows that the skeleton of the two sets of organs will be essentially identical, differing only in such modification as will enable the pinnule to carry ambulacral organs on its ventral side; and, further, that if for any reason the pinnules are not supplied with ambulacral organs on their ventral side the difference between the cirri and the pinnules beyond the second segment will almost or entirely disappear.

In this connection it is most instructive to see that in this specimen the ungrooved pinnules have approached so closely to the cirri in structure that they have taken upon themselves the performance of exactly the same functions.

Genus : COMATULA, Lamarck.

## COMATULA PURPUREA, J. Müller.

*Comatula purpurea*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 746, 1911. A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungsreise, 1905, Bd. 3, Lief. 13, S. 451. 1912. A. H. Clark, The Crinoids of the Indian Ocean, p. 81.

**Locality.** Between Fremantle and Geraldton.

**Material.** Four specimens; one of these is typical, with VIII cirri, three in interradian pairs and two single; another has XI cirri; the cirri in the other two are more numerous than usual, but are evidently undergoing reduction toward the condition normal for the species, indeed in the larger the normal arrangement occurs on about four-fifths of the periphery of the centrodorsal.

In the largest specimen the anterior arms are about 100 mm. long.

The colour in life was reddish purple.

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Sub-fam. : COMASTERINAE, A. H. Clark.

Genus : COMANTHUS, A. H. Clark.

Sub-genus : COMANTHUS, A. H. Clark.

Specific Group : VANIA, A. H. Clark.

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## COMANTHUS (VANIA) ANNULATA, Bell.

*Comanthus (Vania) annulata*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 757. 1911, A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungsreise 1905, Bd. 3, Lief. 13, s. 457.

*Comanthus annulata*, 1912. A. H. Clark, The Crinoids of the Indian Ocean, p. 96.

**Locality.** Between Fremantle and Geraldton.

**Material.** Nine specimens; two of these are uniform light yellowish brown; the other seven are yellowish brown, darkest on the calyx, division series and arm bases where they are thickly covered with small uniform round green spots; according to the label these were dull green in life.

The details of the specimens are as follows: (1) about forty-five arms about 110 mm. long; VI cirri; (2) forty arms about 110 mm. long; X cirri; (3) about forty arms; one of the IIIBr.

series is 7 (3+4, 6+7); the centrodorsal is a pentagonal plate slightly raised above the surface of the radials, with a few obsolete cirrus sockets about its periphery; (4) about forty arms; the centrodorsal is very thin discoidal, pentagonal in outline; there are III cirri; (5) about thirty-five arms about 110 mm. long; (6) about thirty-five arms about 90 mm. long, the centrodorsal is greatly reduced; there are III cirri; (7) about thirty-five arms; VIII cirri; the centrodorsal is greatly reduced; (8) about thirty arms; V cirri; (9) about twenty-five arms about 115 mm. long.

**Remarks.** These specimens agree with those taken by the Hamburg West Australian Expedition at Shark Bay, and with others which I have examined from the vicinity of Perth.

## COMANTHUS (VANIA) PARVICIRRA, J. Müller.

*Comanthus (Vania) parvicirra*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 758. 1911, A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungsreise 1905, Bd. 3, Lief. 13, s. 446.

*Comanthus parvicirra*, 1912, A. H. Clark, The Crinoids of the Indian Ocean, p. 97.

**Locality.** Between Fremantle and Geraldton.

**Material.** One typical specimen with twenty-two arms 70 mm. long; of the ten IIBr. series seven are 4 (3+4) and three are 2; there are two IIIBr. series, one 2, developed internally, and one 4 (3+4), developed externally; the cirri are VIII, 14, 7 mm. long.

**Remarks.** This species has previously been recorded from Fremantle.

Fam.: ZYGOMETRIDAE, A. H. Clark.

Genus: ZYGOMETRA, A. H. Clark.

## ZYGOMETRA ELEGANS, Bell.

*Zygometra elegans*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 762. 1911, A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungsreise 1905, Bd. 3, Lief. 13, s. 458. 1912, A. H. Clark, The Crinoids of the Indian Ocean, p. 104.

**Locality.** Between Fremantle and Geraldton.

**Material.** Eight specimens; the details of these are as follows: (1) forty-five arms 110 mm. long; of the ten IIBr. series

nine are 4 (3+4) and one is 2; of the twenty IIIBr. series seventeen are 2 and three are 4 (3+4); the five IVBr. series are all 4 (3+4); four of them are developed on the outermost side of the ray, the fifth being by the side of one of these; the centrodorsal is large, thick discoidal, the dorsal pole slightly concave, 5 mm. in diameter; the cirri are 30 mm. to 35 mm. in length, and are composed of 44-47 segments; Pd is rather slender, about 15 mm. long, composed of from twenty-seven to twenty-nine segments; (2) forty arms about 100 mm. long; of the ten IIBr. series seven are 4 (3+4) and three are 2; sixteen of the IIIBr. series are 4 (3+4) and two are 2; two are missing; the cirri are 30 mm. to 33 mm. long, and are composed of 37-42 segments; Pd is 18 mm long, rather slender, composed of thirty-seven segments; (3) forty arms about 100 mm. long; the ten IIBr. series are 4 (3+4); twelve of the IIIBr. series are 2 and six are 4 (3+4); the two IVBr. series are 4 (3+4); the cirri are about 30 mm. long and are composed of 38-39 segments; the elongate proximal pinnules are slender; (4) two of the post-radial series are missing; the three post-radial series present consist of eight arms each, two IIBr. and four IIIBr. series being present in every case; all of the IIBr. series are 4 (3+4); nine of the IIIBr. series are 2 and three are 4 (3+4); (5) thirty-eight arms, with one IIBr. series missing; the ten IIBr. series are 4 (3+4); ten of IIIBr. series are 2, six being 4 (3+4); (6) thirty-six arms about 100 mm. long; the ten IIBr. series are 4 (3+4); nine of the IIIBr. series are 2 and seven are 4 (3+4); nine of the IIIBr. series are 2 and seven are 4 (3+4) the cirri are 25 mm. to 35 mm. long, composed of 34-42 segments; (7) thirty-six arms about 100 mm. long; five of the IIBr. series are 2 and five are 4 (3+4); eight of the III Br. series are 2 and eight are 4 (3+4); the cirri are 25 mm. to 30 mm. long, composed of 36-40 segments; (8) thirty-four arms about 100 mm. long; the ten IIBr. series are 4 (3+4); the fourteen IIIBr. series are 2; the cirri are 25 mm. to 30 mm. long, composed of 36-43 segments. The colour in life is recorded as very variable.

**Remarks.** Unfortunately both *Zygometa elegans* and *Z. microdiscus* vary very considerably in their arm structure, and examples of both may easily be found which possess more or less completely developed the arm structure of the other. For instance, the second specimen listed above has seven of the ten IIBr. series

4 (3+4) and sixteen of the eighteen IIIBr. series 4 (3+4); this would indicate the species *microdiscus*; but there are only forty arms, and the character of the proximal pinnules and of the cirri is identical with that of the proximal pinnules and of the cirri of the eighth specimen, which is in every way a typical example of *elegans*.

In *Zygometra comata* from the East Indies, *Z. andromeda* from India and *Z. punctata* from north Australia and the Aru Islands the characters are very stable and variation is reduced to a minimum; but in the larger forms, as in almost all comatulids with a very large number of arms, the arm structure becomes more or less uncertain and less reliable as a systematic guide than the structure of the lower pinnules or of the cirri.

There appear to be two definite and distinct structural types about which all of the large specimens of *Zygometra* centre, and it therefore seems most logical to recognise two species each with a definite pinnule and cirrus structure, and a definite average arm structure.

*Zygometra multiradiata* I believe, from an examination of the type in London, to be merely an undeveloped specimen of *Z. microdiscus*. I would now refer to *Z. microdiscus* the specimens which I recorded from northwestern Australia, and from Lewis Island in the Dampier Archipelago.

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Fam.: HIMEROMETRIDAE, A. H. Clark.

Genus: AMPHIMETRA, A. H. Clark.

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## AMPHIMETRA DISCOIDEA, A. H. Clark.

*Amphimetra discoidea*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 766  
1911, A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen  
Forschungsreise 1905, Bd. 3, Lief. 13, s. 459. 1912, A. H. Clark, The  
Crinoids of the Indian Ocean, p. 112.

**Locality.** Between Fremantle and Geraldton.

**Depth.** 60-100 fathoms.

**Material.** Six specimens. These are all large and well developed, the arms being between 185 mm. and 195 mm. long; the centrodorsal is from 6 mm. to 8 mm. in diameter, very broad, with a flat or more or less convex dorsal pole in the centre of

which there is sometimes to be seen a small pit; the cirri are XX-XXXII, the longest with 37-44 segments, and 35 mm. to 40 mm. in length; they are moderately stout and are composed of approximately sub-equal segments of which the longest (in the proximal portion) are from half again to twice as broad as long, and the distal are slightly shorter.

**Remarks.** The ten armed species of the genus *Amphimetra* are as yet very imperfectly understood. A considerable number of them have been described, mostly based upon single specimens which in several cases are small and probably immature. Extensive material from any one locality commonly shows great variation in one or more of the characters ordinarily used in specific differentiation.

As we know them at present these species appear to fall into three groups; (1) species in which the cirri are very stout with all of the component segments much broader than long, the distal being slightly longer than the proximal (typified by *A. milberti*); (2) those in which the cirri are comparatively slender with the proximal segments never more than twice as broad as long, usually about as long as broad, and always longer than the distal, and in which the dorsal spines on the cirrus segments are small, short and inconspicuous, developed only in the outer portion of the cirri (typified by *A. discoidea*) and (3) those in which the cirri, while in general resembling the cirri of the preceding group, possess large, long and conspicuous dorsal spines which are developed to well within the basal third (typified by *A. jacquinoti*).

The specimens under consideration appear undoubtedly to be exceptionally large and well developed examples of *A. discoidea*; typically *discoidea* has more slender and more tapering cirri in which the longer proximal segments are very nearly or quite as long as broad, but the distal are shorter, broader than long; in typical *milberti* the cirri are much stouter than in these specimens, the segments all being approximately of equal length, though the outer are a trifle longer proportionately, about four times as broad as long.



Fam.: TROPIOMETRIDAE, A. H. Clark.  
Genus: TROPIOMETRA, A. H. Clark.

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### TROPIOMETRA AFRA (Hartlaub).

*Tropiometra afra*, 1911. A. H. Clark, The Recent Crinoids of Australia, p. 780.  
1912, A. H. Clark, The Crinoids of the Indian Ocean, p. 176. 1912,  
A. H. Clark, The Crinoids of the Natural History Museum at Hamburg,  
p. 28.

**Locality.** Between Fremantle and Geraldton.

**Depth.** 60-80 fathoms.

**Material.** Two specimens; one of these has an arm length of about 220 mm.; the centrodorsal is thick discoidal, 10 mm. in diameter and 4 mm. high interradially; the cirri are XXIII, 34-35, 35 mm. to 40 mm. long; the other is similar, with arms 225 mm. long. The colour in life was dark purplish brown.

**Remarks.** This species differs from *T. macrodiscus* of southern Japan in its smaller and more slender cirri; *T. afra*, which is represented in the museums of the world by only three specimens other than the two described above, was previously known only from Bowen, Queensland, where two specimens were collected, more than fifty years ago, by the representatives of the famous Godeffroy company of Hamburg; the third specimen was brought home from the "South Pacific" by the United States Exploring Expedition.

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Fam: CALOMETRIDAE, A. H. Clark.  
Genus: NEOMETRA, A. H. Clark.

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### NEOMETRA GORGONIA, Sp. Nov.

**Locality.** Between Fremantle and Geraldton.

**Depth.** 80-120 fathoms.

**Material.** Seven specimens.

**Description of the type specimen.** The centrodorsal is discoidal, broad, with a broad and flat dorsal pole 5 mm. to 6 mm. in diameter; the cirrus sockets are arranged in one and a partial second crowned and irregular marginal row.

The cirri are XIX, 39-50, 35 mm. to 45 mm. (usually about 40 mm.) in length, long, large and stout, with a pronounced taper in the distal half; the first nine or ten segments are half again to twice as broad as long (usually nearer the latter) the first segment being similar to those succeeding; the segments following the ninth or tenth gradually become shorter, but at the tip of the cirrus slowly increase in length again; the tenth has on the dorsal side just within the distal border an inconspicuous slightly elongated median tubercle which on the succeeding slowly transforms into a narrow and low, though prominent, median carination running the entire length of the segment; on the fifteenth two small tubercles appear, one on either side of the median carination just within the distal edge of the segment; these increase in size and elongate, after two or three segments, becoming prominent low narrow keels which resemble the median keel, though they are slightly less in height and do not extend quite so far toward the proximal border of the ossicle; they are not quite parallel to the median keel, but converge slightly toward the proximal end of the segments; distally all three carinate processes increase in height, especially the median, and a tubercle, which may be more or less elongate, usually appears just outside of the distal end of each of the lateral keels; on account of the terminal taper of the cirri the opposing spine and terminal claw are rudimentary.

The radials are short in the median line, but extend upward in the angles of the calyx in the form of broad processes with parallel or slightly converging sides which entirely and widely separate the bases of the IBr.1; these processes are sharply truncated distally, and are not expanded or spatulate.

The division series and arms extend outward almost horizontally from the calyx, as in *Neometra sibogae*.

The IBr.1; are short, oblong, four or five times as broad as long; the ventrolateral edge is produced into a thin border which, viewed dorsally, is seen to run from the distal edge of the interradi al process of the radials to the distal lateral angles of the IBr.1 where it disappears from dorsal view, being continued along the ventral side of the axillary and of the division series forming a deep trough in which the "soft parts" lie. The IBr.2 (axillaries) are broadly pentagonal, nearly twice as broad as long; the lateral

edges are little, if any, shorter than those of the IBr.1, making with them a broadly obtuse angle. The IIBr. and IIIBr. series are 2, and all of the latter are developed.

There are forty arms (thirty-nine in the type) 95 mm. long, resembling those of other species of the genus; there is little or no overlapping of the distal edges of the brachials.

P<sub>1</sub> is 14 mm. long with twenty-eight segments, of which the first two are greatly enlarged, over twice the breadth of the succeeding, with the distal edge more or less convex, the third or third and fourth are slightly broader than long, and the remainder are subequal, slightly longer than broad; as a whole the pinnule is proportionately longer and somewhat stouter and stronger, than is usual in the genus.

P<sub>2</sub> is 18 mm. long and is composed of nineteen segments: it resembles P<sub>3</sub> but is very slightly less stout.

P<sub>3</sub> is 19 mm. long, very stiff and spine-like, composed of nineteen segments of which the first two are broader than long, slightly enlarged, with distal carinate processes the edges of which are straight and parallel to the longitudinal axis of the pinnule or nearly so, the third is nearly as long as broad, and the following are elongate with, after the eighth, produced distal edges which at the prismatic angles are provided with prominent spines.

P<sub>4</sub> is 14 mm. long and is composed of fifteen segments; it resembles P<sub>3</sub>, but is less stout and the two first segments are less enlarged.

P<sub>5</sub> is 10 mm. long, composed of twelve segments; it is more slender than P<sub>4</sub>.

The distal pinnules resemble those of the other species of the genus; they are very sharply triangular in cross section and their ambulacra are provided with very highly developed side and covering plates; they measure 9 mm. in length, and are composed of fifteen segments of which the terminal four or five, upon which the ambulacral grooves do not extend, are abruptly smaller than the preceding.

The color in life is white, with purple bars and blotches on the pinnules.

**The specimens other than the type.** (1) Forty-two arms; there are two IVBr. series, both developed on the inner side of

external IIIBr. series; the dorsal pole of the centrodorsal is 6 mm. to 7 mm. in diameter; the cirri are XXII, 44-46, 35 mm. to 40 mm. long; the colour is white, the outer part of the arms narrowly banded, and the pinnules broadly blotched, with purple; (2) forty-one arms about 75 mm. long; the cirri are XX, 39-44, 35 mm. to 40 mm. long; (3) about forty arms 65 mm. long; the cirri are about 30 mm. long; the colour is white, the arms beyond the division series narrowly and regularly banded with purple, the bands being continued on to the pinnules; (4) forty arms 60 mm. long; dorsal pole of the centrodorsal is 5 mm. in diameter; the cirri are XXI, 34-39, 25 mm. long; (5) about forty arms, there are two IVBr. series; (6) forty arms, similar to the preceding.

**Comparison with related species.** *Neometra gorgonia* is very different from all of the other described species of the genus. As now known the species of this genus, on the basis of the number of their arms, fall into five groups: (1) species having from fifteen to twenty arms (*alecto*); (2) species having twenty arms (*multicolor spinosissima*, *conaminis*); (3) species having thirty arms (*acanthaster*); (4) species having from thirty to forty arms (*sibogae*); and (5) species having forty arms (*gorgonia*). The only species with which this can possibly need comparison is *N. sibogae*.

On the terminal twelve or thirteen cirrus segments in *N. sibogae* the high median carination is accompanied on either side by a usually more or less elongate tubercle which, however, is comparatively small and inconspicuous. I did not notice this until my attention was called to the similar, but far more prominent, processes in *N. gorgonia*.

In *N. sibogae* the edges, both proximal and distal, of the elements of the division series and the proximal brachials, and the distal edges of the brachials and of the cirrus segments are prominently everted, giving the animal a curiously ornate appearance; in *N. gorgonia* the edges of the elements of the division series, brachials and cirrus segments are smooth, so that the general aspect of the two forms is strikingly different; the cirri of *N. gorgonia* are very much longer than, in fact nearly twice as long as, the cirri of *N. sibogae*, and the three keels on the dorsal side of the outer segments are very much more strongly marked; the cirrus segments in *N. gorgonia* are much more numerous than in *N. sibogae*.

## NEOMETRA CONAMINIS, Sp. Nov.

**Locality.** Between Fremantle and Geraldton.

**Depth.** 80-120 fathoms.

**Material.** Four specimens.

**Description of the type specimen.** The centrodorsal is of medium size, discoidal, the dorsal pole flat, 4.5 mm. in diameter; the cirrus sockets are arranged in a single more or less irregular marginal row (in one of the other specimens there is also a very deficient second row).

The cirri are XIV (in the other specimens varying from XIV to XIX), 40-45, 25 mm. long; the longer earlier segments are half again as broad as long to nearly as long as broad, and the shorter distal segments are about three times as broad as the median length, becoming longer again terminally; the cirri are not particularly stout; they taper slowly and gradually throughout their whole length; on the sixth or seventh segment the median dorsal portion of the distal edge becomes slightly prominent; this prominence rises in height and slowly extends itself proximally until on about the tenth there results a narrow median keel running the whole length of the dorsal surface; on the succeeding segments this gradually increases in height, becoming the high thin median carination characteristic of the outer cirrus segments of the species of this genus; the ventral surface of the cirri is rather narrowly rounded so that in cross section the cirri are seen to approach a rhombic shape, but with the four angles of the rhombic outline very broadly rounded.

The radials are concealed in the median line, but extend upward in the angles of the calyx in the form of triangular processes of which the sides, which are about as long as the bases, are concave and the apices are truncated; the apices of these triangular processes entirely, though not very widely, separate the bases of the IBr.1.

The IBr. 1 are very slightly trapezoidal, almost oblong, from three to four times as broad as long; the ventrolateral edges, though sharp, are only very slightly if at all produced; these ossicles occasionally bear an obscure low median keel; the IBr.2 (axillaries) are broadly pentagonal, slightly broader than long, the lateral edges usually slightly shorter than those of the IBr.1.

The twenty arms, which resemble those of related species, are from 85 mm. to 90 mm. long.

P<sub>1</sub> is 9 mm. long, composed of from twenty-five to thirty segments of which the first two are greatly enlarged and the remainder are slightly longer than broad; P<sub>2</sub> is 12 mm. long, with sixteen or seventeen segments which after the third become much elongated, those in the outer part of the pinnule having produced distal edges bearing prominent spines at the prismatic angles; the pinnule is stiff and spine-like; P<sub>3</sub> is from 15 mm. to 17 mm. long with from sixteen to eighteen segments, resembling P<sub>2</sub> but proportionately larger; P<sub>4</sub> is 17 mm. long with eighteen segments, similar to P<sub>3</sub>; P<sub>5</sub> is 12 mm. long with fifteen segments, similar to the preceding; P<sub>6</sub> is 10 mm. long with fourteen segments; the distal pinnules are about 11 mm. long.

The colour in life is white with yellow bands on the arms and pinnules, more rarely on the cirri.

*The specimens other than the type.* Three, all with twenty arms, and all resembling the type.

*Comparison with related species.* The species of the genus *Neometra* at present known are seven in number; they may be briefly diagnosed as follows:—

*Neometra alecto*; Fifteen to twenty arms, 60 mm. to 70 mm. long; cirri IX-XV, 39-46, 25 mm. to 30 mm. long (Philippine Islands; 42-58 fathoms).

*Neometra multicolor*; Twenty arms, 60 mm. long, cirri XV, 35, 20 mm. long (southern Japan; 20-110 fathoms).

*Neometra conaminis*; Twenty arms, 85 mm. to 90 mm. long; cirri XIV-XIX, 40-45, 25 mm. long (southwestern Australia; 80-120 fathoms).

*Neometra spinosissima*; Twenty arms, 130 mm. long; cirri XI, 42-55, 25 mm. long (Andaman Islands).

*Neometra acanthaster*; Thirty arms, 60 mm. long; cirri 20 mm. long, ventrally carinate (Philippine Islands; 49 fathoms).

*Neometra sibogae*; Thirty to forty arms, 70 mm. to 75 mm. long; cirri XV, 31-36, 25 mm. long; edges of all the ossicles produced; terminal cirrus segments with triple dorsal processes (Solor Strait, east of Flores; 113 metres).

*Neometra gorgonia*; Forty arms, 95 mm. long; cirri XIX, 39-50, 35 mm. to 45 mm. long; edges of all the ossicles smooth; all of the dorsal processes on the cirrus segments triple, the terminal often with two additional elements (south-western Australia; 80-120 fathoms).

From an examination of the data given above it is evident that *N. conaminis* belongs to the group of species characterized by the possession of twenty arms, including *N. alecto*, *N. multicolor*, and *N. spinosissima*.

The Japanese *N. multicolor* is much smaller than *N. conaminis*, and possesses shorter cirri with considerably fewer segments; *N. spinosissima* from the Andaman Islands is much larger with proportionately shorter cirri which have more numerous segments; *N. alecto* is of about the same size as *N. conaminis*, and possesses cirri with the same number of segments; the cirri of *N. alecto* are proportionately noticeably longer and more slender than are those of *N. conaminis*, while the brachials and cirrus segments have slightly produced distal edges, these being smooth in *N. conaminis*.

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Fam: THALASSOMETRIDAE, A. H. Clark.

Genus: PTILOMETRA, A. H. Clark.

## PTILOMETRA MACRONEMA, J. Müller.

*Ptilometra macronema*, 1911. A. H. Clark, Bull. du mus. d'hist. nat. de Paris, No. 4, 1911, p. 255, fig. i B, p. 256. 1911, A. H. Clark, The Recent Crinoids of Australia, p. 781. 1911, A. H. Clark, Ergebnisse der Hamburger sudwest-Australischen Forschungreise, 1905, Bd. 3, Lief. 13, S. 461. 1912, A. H. Clark, The Crinoids of the Indian Ocean, p. 189.

**Locality.** Off Geraldton; "very abundant."

**Depth.** 25-40 fathoms.

**Material.** Ten specimens, all of medium size, the arms being 45 mm. to 55 mm. in length from the radials and the longest cirri about 45 mm. long, composed of 69-78 segments; six of the examples have twenty arms, two have nineteen, one has sixteen and one has fourteen.

The colour in life is recorded as purple, the cirri red. In spirits the colour is yellowish-brown, the cirri becoming deep purple in the outer half.

# THE ECHINODERMS

OF THE

## WESTERN AUSTRALIAN MUSEUM.

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HUBERT LYMAN CLARK, PH.D.

Museum of Comparative Zoölogy, Cambridge, Mass., U.S.A.

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The authorities of the Western Australian Museum at Perth, having entrusted to me their collection of echinoderms for identification and study, I beg to offer here my sincere thanks for the honor they have thus done me. My obligation to Mr. Bernard H. Woodward, the director of the Museum, is particularly heavy, for his uniform courtesy and for the many favours he has shown me.

The collection itself is not a large one but it is of extraordinary interest, not only for some of the hitherto undescribed species it contains, but also for the light it throws on the range of many East Indian and Australian echinoderms. The number of specimens sent me is only 99, but the number of species is more than half that, no less than 58 being represented. The collection is thus a selected one, usually only one or two specimens representing each form. There is thus no opportunity for me to comment on the variability of these West Australian species.

The collection is notable for the large number of new and remarkable species it contains. There are no new crinoids, but five starfishes are undescribed, and one of these represents a new and remarkable genus, while three others are notably distinct forms. Of the ophiurans, four are new, one representing a new genus and the other three being very different from any near allies.

Of the echini, four, and probably five, are undescribed, and it is interesting to note that one of these is a cidarid, and another a centrechinid, the two oldest groups of Recent echini, while the other two are clypeastroids, a group particularly abundant and widespread in Tertiary times. Of the holothurians, certainly two, and



probably three, represent new forms, one of which may ultimately require a new generic name to emphasise its peculiarities. There are thus not less than 15 new species in this small collection, or more than a fourth of the total number. Of the others, at least 22 are not known from outside the Australian region. As 5 are not certainly identified, it follows that of 53 species, 37 or 70 % are characteristic of Australia, certainly a very notable fact. Of course, further knowledge of both the Australian and East Indian faunæ, will alter these figures, perhaps materially, but they are at least suggestive of the remarkable echinoderm fauna which awaits further study on the western coast of Australia.

Finally, the collection at hand is notable for the presence of many species whose occurrence on the western side of Australia was not previously known, and in some cases at least was hardly to be expected. Among the starfishes, the most notable case is that of *Anseropoda rosacea*, previously known from Japan and the Bay of Bengal. Among ophiurans, there are two species, *Pectinura dyscrita* and *Ophiothrix spongicola*, previously known only from New South Wales. Among echini, the occurrence of a *Temnopleurus* is particularly remarkable, while the presence of *Tretocidaris bracteata*, previously known only from the East Indies and Japan, is most interesting.

Holotypes of the new species described in this paper are in the Western Australian Museum at Perth, but cotypes of ten of them (wherever the holotype was not the only specimen) are now in the Museum of Comparative Zoölogy.

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## CRINOIDEA.

There are only five crinoids in the collection. One of these (No. 4922) is a damaged calyx with only the basal part of the arms, and hence is not identified, but it is certainly not one of the Comasteridae. The other four represent four different species, but all belong to the single family Comasteridae. The chief interest of these crinoids lies in the fact that one of the species is new to the fauna of Australia, not being included in the list of "Recent Crinoids of Australia" published in 1911 by Mr. Austin Hobart Clark.<sup>1</sup>

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<sup>1</sup> Clark, A. H., 1911. "The Recent Crinoids of Australia," Mem. Austr. Mus., IV, pt. 15.

## COMATULA SOLARIS.

Lamarck, 1816. Hist. Nat. Anim. s. Vert., vol. 2, p. 533.

This species is well-known from Queensland and Torres Strait, and has been recorded from as far west as Holothuria Bank. Its occurrence on the western coast of Australia is therefore not remarkable. The specimen in the present collection is in what Mr. Clark (l.c.) calls the "broad-armed and generally robust phase" and is unicolor—almost black.

Coast of West Australia. One specimen. No. 260.

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## COMANTHUS ALTERNANS.

*Actinometra alternans*, P. H. Carpenter, 1881. Notes from Leyden Mus., vol. 3, p. 208.

This species has been recorded from the Philippines and from Port Molle, Queensland. Its occurrence, therefore, at the Abrolhos Islands, North-western Australia, is of no little interest. The specimen before me is small, having only 34 arms, each about 60 mm. long, which is an inaccurate way of saying that the tip of each ray is a little more than 60 mm. from the centre of the disk. There are two cirri, attached to the margin of a flat centre-dorsal less than 3 mm. in diameter; the larger cirrus is broken; the smaller has 15 very short, slightly swollen joints. In three of the rays the II Br series is 4 (3+4), the III Br is 2, and the IV Br is 4 (3+4) again; in a fourth ray, on one side, III Br is 4 (3+4) and IV Br is 2; in the fifth ray, on both sides II Br is 2; and III Br is 2 also. The colour of this specimen is light wood-brown. On account of its small size and the fact that the two arms fail to show the regular alternation of the division series, I have hesitated in calling this specimen *alternans*, but I think there is really little doubt that it is a young example of that species.

Abrolhos Islands, Western Australia. One specimen, No. 125.

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## COMANTHUS PARVICIRRA.

*Alecto parvicirra*, J. Müller, 1841, Arch. f. Naturg., Jhrg. 7, vol. 1, p. 145.

*Comanthus parvicirra*, A. H. Clark, 1911. Mem. Aust. Mus., IV, pt. 15, p. 758.

The occurrence of this species in the collection is quite to be expected since it has been previously recorded from Fremantle.

Coast of West Australia. One specimen, without number.

## COMANTHUS POLYCNEMIS.

A. H. Clark, 1910. Proc. U.S. Nat. Mus., vol. 36, p. 396.

The specimen which I refer to this species is a small one, scarcely 120 mm. across, with 57 arms. The colour is a very deep olive-green, but the young arms and the cirri are pale brown or a dirty cream colour. There are 15 cirri, each with 15 joints, but they have the appearance of being fugaceous and the small thin centrodorsal adds weight to such an impression. Unfortunately, Mr. Clark's description is rather unsatisfactory, no statement as to size, colour, or number of arms being made. There is a vague reference "to my previous list," but I have not succeeded in finding the list to which he refers. It is possible, therefore, that I am wrong in referring this specimen to *polycnemis* (especially in view of the presence of numerous cirri) but the arrangement of the division series is a very noticeable character.

Abrolhos Islands, Western Australia. One specimen, No. 124.

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ASTEROIDEA.

The starfishes are a most interesting section of this collection, since five of the sixteen appear to be undescribed, and one of these represents a new and interesting genus. Of the sixteen species, only three are certainly known from outside of the Australasian region.

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LINDIA MACULATA.

Müller and Troschel, 1842. Sys. Ast. p. 77.

A small specimen, with four of the seven arms broken, proves this widespread species to be a native of the West Australian coast. The colour in life is recorded as "buff with dark bands." R.= 80 mm.

Between Fremantle and Geraldton, W.A., 80-120 fms., No. 4919.

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TOSIA AUSTRALIS.

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 281.

Since the type of this species was from Swan River, Western Australia, it is not strange that it should be represented in the present lot.

From piles of an old jetty, Fremantle, W.A. Two specimens, No. 6045.

PENTAGONASTER STIBARUS,<sup>1</sup> sp. nov.

## PLATE XVII.

Rays 5.  $R=52$  mm.,  $r=28$  mm. R 2r. Interbrachial arcs well rounded. Rays broad and flat. Breadth at base, 29 mm. Disc large, very little arched; vertical diameter only about 13 mm. Superomarginal plates, 40, that is, eight on each side or four on each margin of each arm; the terminal pair the largest and much swollen; the others are subequal and little swollen. Each plate is surrounded by a single, double or even triple series of minute, crowded, flat-topped granules, but the surface of each plate is perfectly smooth. Inferomarginals 60, that is, twelve on each side or six on each margin of each arm; on each side of the starfish, the six median inferomarginals correspond exactly in position with the superomarginals above them, but the swollen terminal superomarginal overlies three inferomarginals, of which the antepenultimate (and not the penultimate nor the last) is the largest and is slightly swollen. The penultimate is distinctly smaller but is equally swollen, while the last is quite small and is almost or quite flat. The inferomarginals are smooth and surrounded by granules exactly as are the superomarginals.

The plates covering the abactinal surface are smooth, polygonal or rounded and surrounded, like the marginals, by a series of flat-topped granules. The largest are in the interradial areas and are four or five millimetres across; the smallest are near the tips of the rays. Distally, the median radial series are slightly swollen, while proximally, in the type (the larger specimen), each plate bears a blunt low spine, or high tubercle. Two or three plates not in the median radial series, but near the centre of the disk, bear similar but small tubercles. In the smaller specimen ( $R=41$  mm.) such a tubercle is indicated on only one plate, the dorso-central, while the five primary interradial plates are much larger and more conspicuous than in the type. In both specimens, the rounded triangular madreporic plate lies just distal to one of the primary interradials; in the type, it is much swollen.

The actinal surface is covered by polygonal plates similar to those of the abactinal side and like them surrounded by series of granules. Adjoining each mouth angle is a single plate, distal to

<sup>1</sup> GR. *stibarus*—compact, sturdy.

which are a pair of plates of about equal size. Distal to them is a series of three or four plates. Theoretically this series is succeeded by one of six and that by one of eight plates, the median four of which abut on the inferomarginals. Actually, however, these last two series are irregular in number, form, size and position of the plates. In any case, however, the plates which abut on the inferomarginals are the smallest and those next the mouth plates are the largest of the actinal intermediate plates.

The adambulacral plates are about twice as wide as long. Their armature consists of a series of three stout, blunt, somewhat prismatic, furrow-spines, of which the middle one is either the largest or the smallest. This series is parallel to the furrow, and directly back of it, on the surface of the plate, is a second series of similar, but shorter and stouter spines. There may be either two or three spines in this series but three seems to be the typical number and when there are only two they are exceptionally stout. The remaining surface of each plate is covered by six to ten small, low, truncate, prismatic spines, arranged in series of three (rarely two or four) parallel to the furrow; the outermost are very similar to the granules surrounding the actinal plates. The armature of the oral plates consists of six large marginal spines on each side of the "jaw," the two at the apex being the largest. On the surface of each jaw there are six to ten similar but smaller spines (three to five on each side) while the low keel of the jaw is concealed by about eight thick prismatic spinules arranged in a double series.

Excavate pedicellariae, similar to those of *P. pulchellus* and *P. diibeni*, but smaller than those of the former and larger than those of the latter, occur on many of the abactinal plates. None were found on the actinal surface of either specimen. They occur irregularly scattered and may be present on any plate, but no plate carries more than one. They may have either two or three valves; in the smaller specimen they are mostly two-valved, but in the type, the three-valved form predominates.

Colour of type, very pale fawn; the smaller specimen is brown-yellow. In life, the colour of both was "bright orange."

Between Fremantle and Geraldton, W.A. 40-100 fms. Two specimens, No. 4916. The larger specimen is the Type.

This species is obviously related to *P. diibeni*, Gray, but is at once distinguished by its much broader rays, covered by nearly

circular plates, in three-five longitudinal series, and the much larger terminal superomarginal plates. In *dübeni* when  $R=41$ ,  $r$ =only 17; the arm is 20 mm. broad at base and only 11 mm. at a point halfway between tip and centre of disk; there are 50-60 superomarginals. In *stibarus* with  $R=41$  mm.,  $r=23$ ,  $br=26$  and  $br$  at the middle of arm=20 mm. there are only 40 superomarginals. In *dübeni*, the abactinal plates on the rays are in only 1-3 series, swollen and much elongated parallel to the axis of the ray, but in *stibarus*, they are nearly or quite flat and more or less circular. From *pulchellus*, the type of the genus, *stibarus* differs greatly in the much closer plating of both surfaces, with smaller granules between the plates, and in the pedicellariae being abactinal instead of actinal. If the abactinal tubercles are a constant feature of adult *stibarus*, they will serve as an additional specific character.

Fisher<sup>1</sup> has stated as a character of *Pentagonaster* that it is the last plate of each marginal series which is largest and not the penultimate or antepenultimate. Examination of four specimens of *pulchellus* and three of *dübeni* shows that while it is the last of the superomarginals which is largest, of the inferomarginals, the last is smallest and the penultimate is largest, though sometimes approximately equalled by the antepenultimate. In the type of *stibarus* as already stated, the antepenultimate superomarginal is largest, but in the smaller specimen in only two of the ten possible cases is the antepenultimate largest, in the other eight it is the penultimate which exceeds. This difference, however, is more important on paper than in reality for in every series in the two specimens it is the fourth plate from the median interradian line which is enlarged and the apparent difference is due to whether one or two small plates are developed distal to it. The characteristic arrangement of the marginals in *Pentagonaster* may then be stated thus: The last superomarginal plate is enlarged and swollen and overlies the last two or three inferomarginals; of these the penultimate, or sometimes the antepenultimate, is largest.

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<sup>1</sup> 1911. Bull. U.S. Nat. Mus., No. 76, pp. 166 and 171.

## NECTRIA OCELLIFERA.

*Asterias ocellifera*, Lamarck, 1915. Anim. s. Vert. vol. 2 p. 553.

*Nectria ocellifera*, Gray, 1840. Ann. Mag. Nat. Hist. vol. 6, p. 287. (*oculifera* lap. cal.)

The number of species in the genus *Nectria* has for many years been a matter of dispute. Perrier first called attention to the differences between the original specimens at Paris and the specimens in the British Museum. He <sup>1</sup> was sure they represented two different species and suspected that there was possible a third in the Paris Museum. Sladen, <sup>2</sup> however, on the basis of the *Challenger* material was inclined to think that there was only a single species, the differences to which Perrier called attention not being of specific value. Fisher, in a recent discussion of the genus, points out that the material in the M.C.Z. collection indicates the existence of two species. Very recently the M.C.Z. has received from Mr. Joseph Gabriel some well preserved specimens of *Nectria* from Victoria, and these, on comparison with two specimens from West Australia in the present collection, enable me to throw some light on the question.

The West Australian specimens are essentially alike except that one has six rays, and is somewhat smaller than the other. These specimens agree well with Perrier's description of *ocellifera* and I feel little hesitation in referring them to that species. The specimens from Victoria, on the other hand are obviously different and seem to agree very well with Ferrier's description of his species *ocellata* which was based on Gray's specimen in the British Museum. As all my specimens are well-grown and of approximately the same size, it is clear that the differences are not in any way to be correlated with age, and I believe both species are fully entitled to recognition. The most striking difference between them is in the appearance of the dorsal paxilliform ossicles; in *ocellifera* the top of each ossicle is covered by a group of 10-30 flat, irregularly polygonal, well-spaced granules, surrounded by a marginal crown of 10-25 large spaced, flaring flattened scale-like projections; in *ocellata* the top of each ossicle is much smaller and bears 10-30 rounded, well-spaced hemispherical grains, surrounded by a crowded series of

<sup>1</sup> C. Perrier, 1876. Arch. Zool. Exp. vol. 5, pp. 1-6.

<sup>2</sup> W. P. Sladen, 1889. *Challenger* Asteroids, pp. 318-321.

<sup>3</sup> W. K. Fisher, 1911. Bull. U.S. Nat. Mus., No. 76, pp. 163, 164.

15-30 grains, a little higher than, but not essentially different from, those on the top. As a result of this difference in the ossicles the madreporic plate in *ocellata* is plainly visible and the papulae seem larger and more conspicuous than in *ocellifera* where also the madreporic plate is more or less concealed. The marginal plates are more numerous in *ocellata* than in *ocellifera*; in a specimen of the former having  $R=70$  there are 23 superomarginals on one side of a ray, while in an *ocellifera* with  $R=83$ , there are only 18. The actinal intermediate areas are much more closely granulated in *ocellata* than in *ocellifera*, in the latter the separate plates are quite distinctly indicated by the groups of granules which they bear. The figures given by Sladen in the *Challenger* Report are all illustrations of *ocellata* and it seems to me probable that he had not seen *ocellifera*.

Whether the large specimen in the M.C.Z. collection (No. 1932) upon which Fisher made his anatomical investigations is *ocellata* or represents a new species, I am unable to decide. It is much larger than any *ocellata* I have seen, and its peculiarities may be a matter of age, but I confess that I think it likely it represents a third species. The dorsal paxilliform ossicles are close fitting polygons unlike any that I have seen in other Nectrias. On the other hand, the larger specimen of *ocellata* have pedicellariae and occasionally show inter-marginal papulae in the interbrachial arc (though, it must be added, very rarely), while both of these features, particularly emphasised by Fisher, seem to be wanting in the specimens of *ocellifera*. It seems to me that neither is a constant generic character.

Whether *ocellata* and *ocellifera* have distinct geographical ranges remains to be determined. The exact locality whence Lamarck's type came from is not known. The British Museum specimens described by Gray and by Perrier, the *Challenger* material and all of the specimens in the M.C.Z. are from south-eastern Australia or Tasmania, and these are all *ocellata*. The two specimens before me from West Australia are *ocellifera*. So far as the evidence goes, then, the areas occupied by the two species do not overlap.

The West Australian specimens have the following data: Between Fremantle and Geraldton, W.A., 60-100 fms. Colour orange. No. 4914. Two specimens.



STELLASTER MEGALOPREPES, <sup>1</sup> sp. nov.

## PLATE XVIII.

Rays 5.  $R=120$  mm.  $r.=45$  m.  $R.=2\frac{2}{3}r$ . Br at base = 40 mm.; at half-way point, 24 mm. Interbranchial arcs well rounded. Disk large, not highly arched, yet distinctly convex; vertical diameter about 20 mm. Entire abactinal surface covered by a closely granulated membrane, obscuring but not actually concealing the outlines of the underlying plates. Superomarginals, 22 on each side of ray; median interradiat pair about 12 mm. high by 4 mm. wide, but distally the height decreases with little change in width, the fifteenth plate from the interradius being about 6 mm. high by 3.5 mm. wide (or long). At the tip of the ray the 19-21 superomarginals of the two sides are in contact abactinally but the twenty-second pair are so small, they are completely separated from each other by the twenty-first pair being in close contact with the rather large terminal plate. Abactinal ends of superomarginals (except distalmost) rounded wedge-shape, with a group of papulae on either side. No spines, tubercles or pedicellariae on any superomarginals. Abactinal skeletal plates small, largest in interradiat areas, where they may measure nearly five millimetres across. Median radial series consists of about forty plates and runs to a point about nine or ten millimetres proximal to tip of ray, where meeting of superomarginals of opposite sides puts an end to abactinal plating. On each side of median radial series, at base of arm, are two parallel series of somewhat smaller plates; the one adjoining the median series runs about as far as the fifteenth superomarginal while the outer one ends at the eleventh or twelfth. Excepting thirty (more or fewer) distal, medial radial plates and about ten or a dozen distal plates in each of the two adjoining series, all abactinal plates carry sharp conical spines; the largest are situated one at the base of each ray on the first of the median radial plates; these five spines are about five millimetres high and two in diameter, at base; most of the spines are two millimetres high or less, but all if uninjured are very sharp. Papulae numerous but rather small, in groups of 3-20, all over abactinal surface; largest groups between upper ends of superomarginal plates. Madreporic plate, 7 mm. long by 6 wide, rounded triangular, its proximal margin 12 mm. from centre of disk. Arms very distinct.

<sup>1</sup> GR. *megaloprepes*—magnificent, splendid.

Actinal surface, covered, like abactinal, with a closely granulated membranæ, but outlines of plates quite distinct in dried specimen. Inferomarginal plates, 22 on each side of a ray, corresponding exactly in position to superomarginals, and approximating them in size; the distal margin of each is greatly modified by the series of spines borne thereon. Beginning at tip of ray (to pass from simple to complex conditions), each inferomarginal plate carries at or below the middle of its distal margin a stout, flattened, bluntly pointed spine, rather longer than the plate and lying appressed to the surface of the ray and parallel with its long axis. On plates 4-8 a second similar but smaller spine is present, below (*i.e.* actinal to) the first; on plates 9-11, a third spine still smaller arises below the second; on plates 12-14 there is a fourth; on plates 15-18, a fifth; and on plates 19-22, a sixth. On plates 20-22 a second series of two or three spines appears, proximal to the first, at the base of the second and third spines of that series. With increase in number, there is a change of position and a marked increase in length of these marginal spines, so that on the median interradi al inferomarginals, each of which bears 8 or 9 spines, the original first spine is 7 or 9 mm. long, and is borne on the outer proximal corner of the plate.

Actinal intermediate plates rather few (25-30) aside from the actino-lateral series, which reaches scarcely to the middle of the ray; very rarely a small spine, similar to those on the inferomarginals may be seen on one of the distal intermediate plates. Adambulacral plates, about as long as wide; armature in two series, parallel to furrow; an inner series of 6 or 7 slender spines, median longest, adoral and aboral, shorter and subequal; and an outer of 2 (or rarely 3) very broad thin and flat, truncate spines, erect on surface of plate; these flat spines are 3-4 mm. long and 1-1.5 mm. wide. Oral plates with about 7 spines on each side, of which the innermost are longest and stoutest, and are distinctly prismatic; surface of each jaw with about 3 large, flat, thin spines similar to those in outer adambulacral series.

Pedicellariæ abundant and of two kinds. Scattered irregularly over the abactinal surface are small *bivalved* pedicellariæ (using Fisher's terminology), with jaws about half a millimetre long. Less common, and generally situated near a spine, are tall, 2-valved *spatulate* pedicellariæ, with jaws nearly a millimetre high. Bi-

valved pedicellariae sometimes occur with three jaws and they often have the jaws as high as wide. It is easy to follow the transition from bivalved to spatulate pedicellariae, in this starfish. Both kinds of pedicellariae occur on the inferomarginal plates, but the bivalved are much the more common. Large spatulate pedicellariae occur on many adambulacral plates usually at the adoral end between the two series of spines. Groups of 8-20 large bivalved pedicellariae cover the surface of the actinolateral plates and give them a rough appearance; some of these pedicellariae have jaws more than a millimetre long.

The colour of this fine starfish in life is said to have been "buff above, purple star around mouth." The dry specimen is light reddish-buff above and reddish-white below; the oral plates and first four or five actinolaterals on each side of each ambulacral furrow are dull rose-red, but more or less of the centre of each actinolateral plate is whitish, the area increasing on the more distal plates; inferomarginal and adambulacral spines white.

Off Port Hedland, W.A. One specimen, No. 4030. Type.

This beautiful starfish is quite distinct from any other member of the genus, yet seems to be a true *Stellaster*. The inferomarginal spines and the numerous sharp conical spinules on the abactinal surface are characteristic, while the adambulacral armature and the coloration add important distinctive marks.

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## OREASTER GRACILIS.

Lütken, 1871. Vid. Med. f. 1871, p. 260.

This West Australian specimen equals in size that in the British Museum, described by Bell, for R. = 220 mm., but there are only 25 or 26 marginal plates as against 30 in that specimen. There are no data with the present specimen other than the general statement that it is from West Australia.

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## OREASTER NODULOSUS.

*Pentaceros nodulosus*, Perrier, 1876. Arch. Zool. Exp., vol. 5, p. 53.  
*Oreaster nodulosus*, Bell, 1884, Proc. Zool. Soc., London, p. 66.

Although this specimen is much larger than either of those mentioned by Bell, for R. = 120 mm. as against 70 in his larger specimen, there are only two more marginal plates, 19 instead of 17

on each side of a ray. This species is notable, judging from the present individual, for its smooth surface, the plates being flattened, the tubercles rounded and the granulation so even that at a little distance the specimen looks water-worn, an illusion which examination with a lens dispels. The papular areas are small but very sharply defined. There are 14 or 15 tubercles on each median radial ridge; the largest, which is about 13 mm. in diameter and 8 mm. high, is at the radial angle of the disk, the others being successively smaller distally. There are no data with the specimen, but it is from West Australia.

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### CULCITASTER,<sup>1</sup> gen. nov.

Form stellate, but rays short and disk disproportionately large. Marginal plates concealed, except on terminal third of ray. No large terminal marginals. Abactinal skeleton, coarsely reticulate with numerous large papular areas, regularly arranged in sixes or sevens around each plate. Entire animal covered by a closely granulated skin. No large spines or tubercles. Actinal intermediate areas very large covered with a flat pavement of polygonal plate, arranged in very regular series. Bivalved and spatulate pedicellariae present, at least actinally. Type species—*Culcitaster anamesus* sp. nov.

This remarkable genus is so perfectly intermediate between *Oreaster* and *Culcita*, when seen from above, one might find justification for putting the present species in either of those genera. The actinal surface, however, is more distinctive and makes it desirable, if not positively necessary, to establish a new genus. One can easily imagine the rays of an *Oreaster gracilis* being shortened and the disk enlarged and puffed out until its appearance would be very much like that of *Culcitaster*, in its dorsal aspect, and if the process continued until the virtual disappearance of the ray, there would be difficulty in distinguishing such a specimen from *Culcita schmideliana*. But a glance at the actinal surface would be sufficient to distinguish *Culcitaster*, for no *Oreaster* or *Culcita*, now known, has any such regularly tessellated intermediate areas as characterise this new genus.

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<sup>1</sup> *Culcita*, a well-known genus of starfishes + *aster* a common termination for starfish genera.

CULCITASTER ANAMESUS,<sup>1</sup> sp. nov.

PLATE XIX.

Rays 5. R.= 185 mm. r = 110 mm. Br. at base=70 mm. Br. at 20mm. from tip of ray, 28 mm. Disk circular somewhat swollen, at least 200 mm. in diameter, and projecting beyond superomarginals in all interradial areas. Entire animal covered with a closely though rather coarsely granulated skin, which conceals many of the marginal plates but through which most of the abactinal plates are discernible. These plates seem to be rounded or stellate and are united with each other by narrow radiating plates, six or seven to each central plate. All the space between these radiating plates is occupied by papulae, so that the papular areas, each with dozens of papulae, are more or less triangular in shape and are arranged in groups of six or seven around each primary abactinal plate. On the rays, distal to the disk, one can distinguish at least three longitudinal series of plates and hence the papular areas have a linear arrangement. Six or eight superomarginal plates on each side of the tip of the ray are easily recognisable; the last four or five are high and narrow and at least on two arms, the two distalmost pairs meet abactinally in the median line. Terminal plates relatively very small. Tip of ray turned up so far that as in *Culcita*, the ambulacral grooves extend on to the abactinal surface.

Actinal surface flat, tessellated, covering-membrane not concealing the outlines of the plates. Distal to each mouth angle is a large rhomboidal plate about 18 mm. across; from its two distal sides extend the series of conspicuous actinolateral plates, at first nearly square but soon becoming evidently wider than long. Distal to the large rhomboidal plate is a similar but smaller plate, its two proximal sides in contact with the first actinolateral plates; from its two distal sides extend series of plates adjoining and parallel to the actinolaterals. Distal to the second rhomboidal plate is a similar but smaller plate from whose distal sides, series parallel to the actinolaterals again arise. Distal to the third rhomboidal plate is a pair of narrow plates lying side by side, from the distal ends of each of which a series of four or five similar plates extends to the margin of the area. Adjoining each of these series are parallel rows which

<sup>1</sup> Gr. *anamesos*—in the middle; in reference to its intermediate position.

extend from the actinolaterals (beginning with the third) to the margin. At the margin of each interrarial area, the regular serial arrangement of actinal plates is interrupted by the intercalation of small rounded or polygonal plates, some of which also crowd in between the lower ends of the inferomarginals.

Adambulacral plates short and not very wide ; there are about two to each actinolateral plate. Armature in a double series ; inner of 7-9 rather slender spines, parallel to furrow, median longest and adoral and aboral shortest and subequal ; outer of two or three very short blunt spines about 2 mm. long and 1-2 mm. thick, on actinal surface of plate, parallel to furrow, median (or adoral of two) longest and stoutest. Oral plates with about a dozen spines on each margin ; proximal very large, 7 or 8 mm. long, 3 or 4 mm. thick at tip ; distal spines smaller : distalmost grading into inner series of first adambulacral plate ; each oral plate bears on its surface 3 or 4 very stout, low spines, similar to those of the outer adambulacral series.

Pedicellariae abundant on actinal surface, but not observed in this specimen abactinally. On adambulacral plates are very heavy *spatulate* pedicellariae with two jaws ; these are at adoral end of plate and may be one, two or three in number ; if there are two or three, one is usually much the largest. Scattered all over the actinal interrarial areas, but most abundant on the radial ends of the actinolateral plates are *bivalved* pedicelloriae with jaws a millimetre wide or less.

Colour above, light grey ; actinal surface more yellow-brown.

There are no data with this extraordinary starfish, but it is said to have been taken on the coast of West Australia. It is difficult to understand how so large and conspicuous a form should have so long been undescribed, but I can find nothing in the literature which would warrant the belief that specimens had ever been seen by European zoologists. The swollen circular disk beyond which project the short stumpy rays give the animal a very odd appearance, while the regular actinal plating covered with a closely granulated membrane is remarkably distinctive.

There can be little doubt that the genus is intermediate between *Oreaster* and *Culcita*.

LINCKIA TYLOPLAX,<sup>1</sup> sp. nov.

PLATE XX.

Rays 5, R. = 150 mm. r. 25 mm. R. = 6r. Br. at base = 27 mm. Br. at half-way point = 18 mm. Disk small, but much elevated vertical diametre about 20 mm. Rays tapering to a blunt point. Whole body surface covered by a granular membrane; granules largest near the centres of abactinal plates smallest on papular areas. Abactinal skeleton composed of 3-5 irregular series of rounded plates, with smaller plates scattered among them. Larger plates, nearly all swollen into rounded or flat-topped knobs, 2-5 mm. in diameter and about 2 mm. high. Between the plates are papular areas, 2-3 mm. across, with numerous small papulae. Madreporic body large, 7 mm. in diameter, about 15 mm. from centre of disk. Marginal plates fairly distinct, especially near tip of ray. Superomarginals about 43 on each side of a ray, the basal ones at least, knobbed. Inferomarginals of about the same number but less distinctly knobbed. Intramarginal papular areas well developed, nearly to tip of ray. Two series of actinal intermediate plates extend nearly or quite to tip of ray; actinolateral series adjoining adambulacral plates much larger than the second series, except near tip of arm. Papular areas present on actinal surface not only between inferomarginals and actinal intermediate plates but also between the two series of the latter, even on the actinal interradial areas.

Adambulacral plates small; armature characteristically Linckian; each plate bears two short, thick, blunt spines on its furrow margin and a larger tubercle-like spine, 2 mm. long by 1 mm. thick, on its actinal surface. Armature of oral plates similar and equal to that of two adambulacrals. No pedicellariae.

Colour, light brown above, darkest on knobs; actinal surface nearly white.

Between Fremantle and Geraldton, W.A., 80-120 fms.

Two specimens. No. 4931. The larger specimen is the Type.

The presence of actinal papulae would almost warrant a new genus for this interesting starfish. Its abactinal aspect is much like some species of *Nardoa*, but the adambulacral armature precludes its inclusion in that genus. It does not seem to be very nearly related to any other previously known member of the family.

<sup>1</sup> Gk. *tudos*—a knob; *plax*—a plate.

## ASTERINA GUNNII.

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 289.

The occurrence of this species on the West Australian coast is quite to have been expected. All the specimens have six rays.

From piles of old jetty, Fremantle, W.A. Two specimens.

No. 6044. Without data, two specimens in poor condition.

Nos. 146 and 148.

## ANSEROPODA ROSACEA.

*Asterias rosaceus*, Lamarck, 1816, Anim. s. Vert. vol. 2, p. 558, par. 3.

*Anseropoda rosacea*, Fisher, 1906. Bull. U.S. Fish. Comm. for 1903, p. 1089.

This is one of the notable starfishes in the collection, for its occurrence off West Australia is very interesting, even if not surprising. The present specimen is 168 mm. across, and thus somewhat smaller than the specimen described by Müller and Troschel (1842) but larger than the one so finely figured by Koehler in his account (1910) of the shallow-water starfishes of the Indian Museum (Pl. XX). The individual from West Australia is, in its dry condition, dull, deep cream-colour with not very numerous, well scattered small spots of deep purple on the upper surface. It is remarkable for having 16 rays instead of the typical number, 15.

From Port Hedland, W.A. No. 4029.

## ECHINASTER ARCYSTATUS,<sup>1</sup> sp. nov.

PLATE XXI.

Rays 5. R.=130 mm. r.=20 mm. R.=6.5r. Br. at base =24 mm. Br. at half-way point=18 mm. Disk small; vertical diameter about 20 mm. Rays rounded, tapering to a rather blunt point. Abactinal skeleton and that of sides of rays forming a very distinct net-work with meshes 4-10 mm. in diameter, and occupied by 10-60 papulae. The skeletal ridges carry numerous, but well-spaced, bluntly pointed spinelets about a millimetre high. These

<sup>1</sup> GR. *arkustatos*—surrounded with nets, in allusion to the conspicuous reticulations of the abactinal skeleton. By an unusual typographical error in Hinds and Noble's Classic Greek Dictionary, 1901, p. 102, I was led to write the word *acrystata* in naming a brittle star in 1911, Bull. U.S. Nat. Mus. No. 75, p. 145. Under the circumstances, the name given is obviously a typographical error and the brittle-star should be known as *Amphiura arcystata*.



are most numerous and sharpest near tips of rays. Madreporic plate small, only 3 mm. across, and situated only 7 or 8 mm. from centre of disk.

Adambulacral plates short and numerous; each bears a pointed spine, deep in the furrow, and two blunt spines on the furrow margin; these two spines are 1.5-2 mm. long, about .5 mm. wide and are somewhat flattened; the aboral is a trifle smaller and stands further back from the furrow margin. Oral plates each with four marginal spines similar to those of the adambulacral plates, but somewhat larger.

Actinal surface with numerous papulae everywhere. Actinal intermediate areas without spines. Opposite the fifth adambulacral plate, there begins a very distinct series of small sharp spines which runs to the tip of the ray. The fifth adambulacral spines are 5 mm. from the first spine of this series, but at the tip of the ray the distance between the two series is little more than a millimetre. The whole starfish is covered by a skin which is particularly thick and noticeable orally. On the basal half of the arms, very distinct furrows run out at right angles to the long axis of the ray between the adambulacral plates for some distance beyond the actinolateral series of spines just described. In the dry specimen these furrows are very conspicuous because of their lighter colour. There are of course no pedicellariae.

Colour of dry specimen, reddish-brown. In life the colour is said to have been purple.

Between Fremantle and Geraldton, W.A. One specimen, No. 4918. Type.

If we are to distinguish *Othilia* as a separate genus from *Echinaster*, on account of the actinal papulae, then this species belongs to *Othilia*, for the actinal papulae are a very noticeable feature. But the type of *Othilia* is *Edhinaster spinosus* of Brazil, and the present species does not resemble that species in general appearance so much as it does some of the East Indian *Echinasters*. For the present therefore, I have concluded to ignore *Othilia* and describe this specimen as an *Echinaster*. It does not seem to be very closely related to any of the previously known species, but it must be granted that *Echinaster* is a perplexing genus and specific differentiation is not very complete within it. Individual variation

is considerable and there are few characters which seem well to separate the species. A revision of the described species is much needed.

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## ECHINASTER VESTITUS.

*Ophidiaster* (?) *vestitus*, Perrier, 1869. Arch. Sci. Nat., vol. 12, p. 254.  
*Echinaster vestitus*, Perrier, 1875. Arch. Zool. Exp., vol. 4, p. 372.

This specimen has been compared with specimens from Mauritius and Zanzibar labelled *vestitus* by Perrier himself, but owing to its poor condition, due to a peculiar scurfy encrustation all over the surface, I am not wholly satisfied that it is identical with them. There are 5 rays about 120 mm. long, and nearly 20 mm. in diameter at base; they are nearly cylindrical but taper somewhat to a blunt point; 1--16 mm. The abactinal surface and sides of the rays are covered with papulae and numerous small spines, while the skeleton itself is pretty well concealed by the overlying skin. The spinelets are rarely a millimetre long. The adambulacral plates carry only two spines each, one deep in the furrow and a larger blunt, or even slightly clavate spine on the margin. Papulae are not present below what seems to be an inferomarginal series of spines: between this series and the adambulacrals there is a more or less well-marked series of somewhat smaller actinolateral spinelets. Colour, bright yellow-brown.

Off Port Hedland, W.A. One specimen, No. 4031.

The peculiar encrustation on this specimen prevents a satisfactory study of its characters. The nature of this encrustation I have not been able to determine, but it appears to be organic.

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## PLECTASTER DECANUS.

*Echinaster decanus*, Müller and Troschel, 1843. Arch. f. Naturg. Jhrg. 9, vol. 1, p. 114.  
*Plectaster decanus*, Sladen, 1889. *Challenger Asteroids*, p. 535.

The occurrence of this species on the south-western coast of Australia is not surprising, though it is a considerable extension of its known range.

Albany, W.A. One specimen, in poor condition. No. 4859.

## ASTERIAS CALAMARIA.

Gray, 1840, Ann. Mag. Nat. Hist., vol. 6, p. 179.

This species has not been recorded from West Australia hitherto, though its occurrence there is quite to have been expected if Gray's original specimens were really from such widely separated places as Mauritius and Australia.

No data. One specimen, No. 133.

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## ASTERIAS POLYPLAX.

*Asteracanthion polyplax*, Müller and Troschel, 1844. Arch. f. Naturg. Jhrg. 10, vol. 1, p. 178.

*Asterias polyplax*, Perrier, 1875. Arch. Zool. Exp., vol. 4, p. 327.

This is one of those perplexing starfishes, which it is almost impossible to distinguish from *Asterias*, in a broad sense, and which nevertheless seems to belong in the Stichasteridae if that family is to be recognised. As I very much question the validity of this latter family, it seems to me better to keep *polyplax* in the genus *Asterias*, until that assemblage of species is properly broken up into its component parts. As both Verril and Fisher are now at work on this problem, the name *Asterias polyplax* may well be used for a few years more for the present Australasian species.

Between Fremantle and Geraldton, 80-120 fms. One specimen, No. 4917.

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## OPHIUROIDEA.

Although four of the nine species of ophiurans appear to be undescribed and one of these requires the formation of a new genus, the collection from the Western Australian Museum is remarkable for what it does not contain, to nearly as great a degree as for what composes it. The ophiurans of West Australia have recently been the subject of a paper by Koehler<sup>1</sup> based on the collection made by Michaelsen and Hartmeyer in 1905. That collection contained 28 species, of which only three were considered as previously undescribed; one of these was an Ophiacantha and the other two belonged to Ophiothrix, both large, diversified and widespread genera. A fourth species was subsequently described as new by Döderlein<sup>2</sup>, an astrophyton of the genus Astroboa. Of the 28 species, only 3 are in the collection before me. Of the 14 genera collected by Michaelsen and Hartmeyer, only 4 are in this collection; such common genera as Amphiura, Ophiactis, Ophionereis, Ophiocoma and Ophiacantha are entirely unrepresented. On the other hand the two collections contrast with each other sharply in the fact that only one of Michaelsen's and Hartmeyer's species was a Euryalid while five of the nine species before me represent that group. It would be hard to collect two series of Ophiurans from the same region which would differ more strikingly from each other than do the two under discussion. Nor is it easy to suggest any reason for such an extraordinary difference. Possible further studies, made on the ground, may explain the matter.<sup>3</sup>

## PECTINURA DYSCRITA.

H. L. Clark, 1909. *Thetis* Echinoderms. Mem. Aust. Mus., vol. 4, p. 534.

This species, previously known only from New South Wales, is represented by a single specimen in poor condition.

Between Fremantle and Geraldton, W.A. One specimen, No. 4929.

<sup>1</sup> Koehler, 1907. Die Fauna Südwest-Australiens; Ophiuroidea, vol. 1, pp. 241-254.

<sup>2</sup> Döderlein, 1911. Über japanische und andere Euryalae, p. 82.

<sup>3</sup> The explanation of the difference between these two collections appears to be simple. The collection sent to Mr. Clark was entirely composed of specimens trawled by the *Endeavour*, chiefly in depths approaching 100 fathoms. Drs. Michaelsen and Hartmeyer obtained their specimens by dredging in comparatively shallow water in sheltered localities.—W. B. A.

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OPHIOTHRIX SPONGICOLA.

Stimpson, 1855. Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 385.

This is another of the New South Wales species, which might naturally be expected in West Australian waters. For an account of its more recent history see *Thetis* Echinoderms, Mem. Aust. Mus. vol. 4, p. 546.

Between Fremantle and Geraldton, W.A. One specimen in poor condition. No. 4930.

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OPHIOTHRIX STELLIGERA.

Lyman, 1874. Bull. M.C.Z., vol. 3, p. 237.

This species, which was taken by Michaelsen and Hartmeyer at five stations, is represented by a rather large specimen, with disk 8 mm. across, and the most nearly complete arm from 32-35 mm. long. It is in fairly good condition. It seems to have been taken with the previous species, as it was in the same vial and bears the same catalogue number.

Between Fremantle and Geraldton, W.A. One specimen, No. 4930.

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OPHIOMYXA AUSTRALIS.

Lütken, 1869. Add. ad Hist. Oph., pt. 3, p. 45.

This is the second of the three species in this collection, which were also taken by Michaelsen and Hartmeyer; they found it at four stations. It was also taken by the *Thetis* and by the *Challenger*, so it may naturally be considered one of the commonest Australian brittle stars.

Between Fremantle and Geraldton, W.A. One specimen in poor condition, No. 4928.

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ASTROGYMNOTES,<sup>1</sup> gen. nov.

Disk and arms covered with a skin, which apparently contains no calcareous plates, except numerous rounded granules on the upper surface of the arms. No radial shields on upper or under arm-plates are visible. No madreporite. Teeth well developed, but oral papillæ rudimentary. Arm spines and tentacle scales both present and easily distinguishable from each other.

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<sup>1</sup> GR. *aster*—a star; *gymnotes*—nakedness, in allusion to the absence of plates on disk and arms.

Type species, *Astrogymnotes catasticta*, sp. nov.

This interesting new ophiuran, noticeable for being jexamerous, appears to be one of the sub-family *Astroscheminæ* as restricted and defined by Doderlein in 1911. But it is easily distinguished from the other members of that family by the absence of both upper and under arm plates, and the presence of both tentacle scales and arm spines.

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## ASTROGYMNOTES CATASTICTA,<sup>1</sup> sp. nov.

### PLATE XXII.

Rays 6, rarely 7. Disk about 9 mm. across; rays about 45 mm. long. Entire animal covered by a smooth skin, which is perfectly bare, except on the upper surface of the arms and the adjoining portions of the disk, where it is more or less crowded with minute circular bits of lime; about a dozen series of these occupy the width of the arm. Radial shields not visible but indicated through the skin by short radial elevations, a pair at the base of each arm; these are about 3 mm. long. No upper or under arm-plates to be seen even in a dried specimen. Teeth well formed, in a vertical series of five; oral papillae rudimentary, about three on each side of each jaw. No madreporic or oral shields present. Arm-spines present, one on each of the three basal segments, but two on each of the remaining segments; they are less than a millimetre long, cylindrical, blunt and subequal. Tentacle-pores evident, each one guarded by a flat, nearly circular tentacle scale. Genital slits small and oblique, about equal to the length of an arm-joint; two in each interradius. Colour yellow-brown, indistinctly speckled on radial areas of disk, and conspicuously spotted all over the lower surface of disk and arms with pale yellowish white. In dry specimens the colours are dull, the spotting is not so noticeable and the calcareous granules give the upper surface of the arms a whitish cast.

Off Jurien Bay, W.A., 80-100 fms. Ten specimens, No. 4,924.

It is a real satisfaction to have such a good series of this remarkable ophiuran for study. It is probably as nearly related to *Astroschema* as to any known genus, but still retains a distinction between arm spines and tentacle scales. The arms are also

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<sup>1</sup> GR. *catastictos*—spotted.

relatively much shorter than is usual in that genus. Several of the specimens show by their unequal development that reproduction by fission is normal for the species.

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### OPHIOCREAS MELAMBAPHES,<sup>1</sup> sp. nov.

Rays 5. Disk about 6.5 mm. in diameter, with arms about 120 mm. long and 2 mm. thick. Entire animal covered with a thick smooth skin, through which, in dried specimens, the radial shields and side arm-plates are revealed. The radial shields are about 3 mm. long by one mm. broad, and are perfectly smooth, though slightly swollen. There are no calcareous granules in the skin of the dorsal surface on either disk or arms. Teeth 4 or 5, the lowest often displaced and somewhat deformed. Oral papillae wanting. No oral shields or madreporite. First two pairs of the very small tentacle-pores bare, but all subsequent pores guarded by two spine-like tentacle-scales of which the inner is a trifle the longer and is about half a millimetre long. Genital slits very small, less than a millimetre long, oblique, crescentic; two in each interbrachial space.

Colour, deep purple or purplish black above and on sides, but actinal surface of disk and arms dull cream colour.

Off Jurien Bay, W.A., 80-100 fms. Two specimens, No. 4,925.

The smaller specimen is the Type.

Although this species resembles *O. silogae*, Koehler, in many characteristic features, it is distinguishable from that species at a glance by its different proportions, different tentacle-scales and strikingly different colour. Döderlein does not consider the character by which *Astroschema* differs from *Ophiocreas* sufficiently constant to warrant the maintenance of the two genera, but I am inclined to think that while our definitions will need to be readjusted, the two groups had better be retained. The present species is a typical *Ophiocreas* so far as its external covering is concerned.

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<sup>1</sup> *Gr. melambaphes*—dark-dyed.

## OPHIOCREAS RHABDOTUM,<sup>1</sup> sp. nov.

Rays 5. Disk 5 mm. in diameter, with arms about 78 mm. long. Very similar to the preceding species, but arms shorter and more slender, radial shields shorter and less prominent and teeth sharper and more regular. Only the first pair of tentacle-pores lacks tentacle-scales.

Colour dull yellow, speckled and streaked on disk with blackish: a broad blackish stripe runs the length of the arm in the median line abactinally, but under the lens, even this stripe is found to be finely speckled with yellowish; just above the tentacle-scales there is on each side of the arm, a very narrow and often indistinct blackish stripe.

Off Jurien Bay, W.A., 80-100 fms. Two specimens, No. 4,926.

The larger specimen is the Type.

As this form was taken at the same station with the preceding, I think it quite possible that it is only a colour phase of that species. But the colour difference is so marked, and the two specimens of each species are so distinctly characterised thereby, I have felt it was more satisfactory to designate them by different names. Further investigation on the West Australian coast is necessary for a correct settlement of the question.<sup>2</sup>

## CONOCLADUS MICROCONUS.<sup>3</sup> sp. nov.

PLATE XXV.

Rays 5, but in the type specimen there are 6. Disk, 35 mm. in the type, in the smaller specimen 27 mm. in diameter, with arms about 90 or 100 mm. long and 10 mm. wide at base; height of arm near disk, 5-6 mm. Radiating wedges of disk separated from each other by five (in the type, six) narrow deep grooves, which are

<sup>1</sup> Gr. *rhabdotos*—striped.

<sup>2</sup> The two supposed species of *Ophiocreas* were obtained together in large quantities attached to one particular species of Hydroid, with which their arms were so much intertwined that it was very difficult to remove them, except in fragments. Whilst I entered them under two numbers, I made a note at the time that they were "probably colour varieties of one species"—W. B. A.

Gr. *mikros*—little; *konos*—cone; in reference to the small size of the cones on the disk.



practically filled up by the small, rough cones of the disk plates. Each wedge is covered by a rough, uneven pavement of plates, grains and granules, rarely smooth, but usually bearing a ridge, lump or small cone. These cones are of very diverse sizes and shapes; they are rarely a millimetre high and are very seldom pointed; they commonly terminate in a group of 3-15 little spinules. This irregular and very rough pavement extends out on the area so that there is no line of division between the latter and the disk. None of the cones are enlarged nor have they any definite arrangement. The arms branch about eight times; the first division being about 22-27 mm. from the disk; the resulting branches after each division are often very unequal. Beyond the second fork the branches become long and very slender and are covered by alternating paired half-circles of granules and glassy hooklets. Oral surface of disk and arms covered with small roundish flat granules, most numerous on the mouth angles and bases of the arms. Tentacle-pores small; first pair (not counting buccal tentacles) well within disk, with no tentacle-scales. Each succeeding pore is more or less concealed by a slight ridge on its adoral side, which carries 4 (rarely 3 or 5) short, slightly curved peg-like spines, rather more than half a millimetre long. Each spine is compressed and its terminal margin divides into 3-5 little glassy spinelets. Each mouth angle carries a cluster of twenty or more spiniform teeth and similar but shorter papillae. Genital slits small, hardly 2 mm. long, and more or less concealed. Madreporic plate distinct, hardly 2 mm. across.

Colour, uniform light brown; in life, "dull brown."

Between Fremantle and Geraldton, W.A., 80-120 fms. Two specimens, No. 4921.

The larger specimen, although 6-rayed, is selected as the Type.

The occurrence of a new species of *Conocladus* in West Australian waters is most interesting, the two previously known species having been reported only from New South Wales. As Döderlein (1911, *Über Japanische und andere Euryalae*, p. 68) has pointed out *Conocladus* is in certain respects a very primitive form mostly nearly allied to *Astroconus australis*, Verr. This discovery of a third well-marked species would seem to indicate that Australia is emphatically the home of these primitive Eurylids and even suggests that it may have been the ancestral home of the whole order.

The West Australian species is very easily distinguished from its New South Wales congeners by the entire absence of large cones or tubercles on the disk.

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## ASTROBOA ERNAE.

Döderlein, 1911. Über japanische und andere Euryalae, p. 82.

It is interesting to find specimens of this species in the collection since it was hitherto known only from the holotype, a specimen 22 mm. across the disk. One of the present specimens is only 15 mm. across the disk while the others are nearly 40. But I have nothing to add to Döderlein's careful description. The colour of these individuals in life is said to have been "buff or leaden." In alcohol, they are a peculiar shade of purplish brown, which is hard to name. On drying, they become very light, almost a dirty white, with a purplish cast.

Off Geraldton, W.A., 29 fms. Three specimens, No. 4923.

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## ECHINOIDEA.

Although the collection of Echini is remarkable for the large number of species it contains, yet eleven species which were in the *Thetis* collection from New South Wales are not represented here. Several of these are common littoral forms of wide distribution and will probably be found hereafter on the West Australian coast. As already noted, four and possibly five of the nineteen species are new to science, and belong in groups of more than usual palaeontological interest.

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## PHYLLACANTHUS MAGNIFICUS,<sup>1</sup> sp. nov.

PLATE XXVI.

Test nearly spherical, 92 mm. in horizontal diameter and 72 in vertical; hence v.d.=.78 h.d. Longest primary, about 75 mm. in length, 10 mm. in diameter near base and 5 mm. in diameter at tip. Interambulacral plates 10 in each column, all, except sometimes, the uppermost with a long, stout primary spine. Interambulacra

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<sup>1</sup> The origin and significance of this name are obvious.

43 mm. wide; ambulacra nearly 13 mm.; hence interambulacra more than three times as wide as ambulacra. But median interambulacral space only 11 mm. wide, and hence only one-fourth of interambulacrum. Median ambulacral area less than 6 mm. wide, and hence less than half the ambulacrum. Abactinal system 28 mm. in diameter and actinostome the same.

Genital plates moderately large, about 11 mm. wide by 7 mm. high, but madreporic genital very large, nearly 16 mm. wide by 11 mm. high. Oculars small and low; ocular V insert, and I nearly so; in the smaller specimen, all the oculars are exsert but V is nearly in. Genital pores large, near centre of plate, surrounded by a circle of about a dozen broad flat spinelets larger than the others on the plate; as these spines are closed over the pores, they form a conspicuous conical elevation. Ocular pores small near distal margin of plate. Interambulacra, median areas of ambulacra, abactinal system and actinostome, densely covered with small flattened bluntly pointed spinelets and pedicellariae. Secondary spines of interambulacra in circles of 15-20 around the bases of the primary spines; they are broad, flat and truncate, about 8 mm. long by 2 mm. broad. Along the margin of the median area of each ambulacrum is a series of narrow, flat spines, about 4 mm. long and .5 mm. wide, which lie flat across the poriferous areas. Between these marginal series are four or five series of smaller spines or spinelets similar to those on the interambulacra. Pores of a pair rather large wider than high, separated by a space wider than the width of a pore and connected by the groove characteristic of the genus.

Pedicellariae present in great numbers. The tridentate show little diversity in size, but are chiefly actinal in position and on the interambulacra. Their valves are about two millimetres long, but the blade is only about .25 mm. wide, so they are very slender; the valves meet only at or near the tip. There is a single vertical ridge extending the length of the blade in the median line on its inner surface similar to those found in the tridentate pedicellariae of *P. imperialis*, but rather more prominent; it is sharply serrate, more coarsely so than the margins of the blade. The small globiferous pedicellariae are abundant almost everywhere and are very similar to those figures by Mortensen for *P. Imperialis*. Their valves are about .30 mm. long. The large globiferous pedicellariae are very common, particularly on the ambulacra; the valves are .80-.90 mm.

long, but the stalk is little more than half that ; it has no "limb." The valves are shaped very much like those of the small globiferous pedicellariae, but the terminal opening is surrounded by coarse, curved teeth. This opening is very variable in size and form ; it may be less than one-fourth the length of the valve or it may be nearly two-fifths ; it is often of some peculiar shape and not rarely is divided vertically into two openings ; even when the opening is short there is little tendency towards a "snout-like" blade. The large globiferous pedicellariae vary very little in size and do not seem to intergrade at all with the small ones.

Primary spines very stout, rough with small rounded granules, which soon become more or less completely concealed by a spongy alteration in the outer layer of the spine and the profuse growth of bryozoa, sponges and other organisms which cover the old spines. At the tip, the series of rounded granules are arranged longitudinally and pass into ridges which surround the blunt end of the spine. Young spines are bluntly pointed but become more and more flaring with age and the actinal primaries are particularly notable for their stoutness and flaring tips. The thickness of some of these at tip may be equal to one fourth or even almost one-third the total length of the spine. There are 24-36 longitudinal ridges around the tips of the larger primaries. The collar is low, seldom over 3 mm. in height.

Colour, deep red-brown, so far as secondaries, miliaries and pedicellariae are concerned ; young primary spines yellow-brown, but rapidly darkening with age ; the collar remains yellow-brown throughout life, but the rest of the spine, where not covered by foreign growths, has a marked purplish-red shade.

Between Fremantle and Geraldton, W.A. Two specimens, No. 4935. The larger is the Type.

The type specimen of this fine new species is one of the largest and most perfectly preserved cidarids I have ever seen. The other specimen is 75 mm. h.d. and 51 v.d., so that v.d. is little more than .66 h.d. There are 8 or 9 interambulacral plates in each column. In other particulars the specimens differ little from each other. While the relationship to *imperialis* is obvious, this species is easily distinguished by the remarkable actual primaries and the large number of coronal plates. To no other of the Recent species of the genus does it show any close relationship.

## PHYLLACANTHUS ANNULIFERA.

*Cidarites annulifera*, Lamarck, 1816. Anim. s. Vert., vol. 3, p. 57.

*Phyllacanthus annulifera*, A. Agassiz, 1872. Rev. Ech., Pt. I, p. 150.

There is a beautiful cidarid in the collection which seems to belong to this species although the coloration is different from that of any *annulifera* I have seen. The test is 30 mm. l.d., and the primaries, which are very thorny and quite free from foreign matter are about 40-45 mm. long; the collar is 4 mm. high. The ocular plates are all insert, but II and III are only barely so.

The test is cream-colour, or almost pure white on the bare median ambulacral area; the miliary and secondary spines are almost white, or at least very light coloured, with a broad longitudinal stripe on their upper (or outer) surface of bright brown, which is darkest on the smallest spines and palest on the largest; actinally the brown is almost brownish-red. The primary tubercles and the collars of the primaries are bright pinkish lavender. The primary spines are light coloured with a markedly greenish cast, and with almost eight bands of dull purplish-red; these bands are broken on the sides of the spine and are faint on the lower surface; the thorns on the actinal primaries are red, often with white tips, and the primaries close to the actinostome have the entire tip red.

Port Hedland, W.A. One specimen, No. 4026.

## TRETOCIDARIS BRACTEATA.

*Dorocidaris bracteata*, A. Agassiz, 1879. Proc. Amer. Acad., vol. 14, p. 197.

*Tretocidaris bracteata*, H. L. Clark, 1907. Bull. M.C.Z., vol. 51, p. 206.

These specimens are larger than any previously known, having h.d.=35 mm. The primaries are 50 mm. or more in length, and are 4 mm. broad near the base; they are somewhat flattened there and the longitudinal ridges are very prominent; these latter are broken up into flattened truncate or sharp teeth, making the spines conspicuously and coarsely rough. The collar on the primaries is very low, which is one of the best characteristics of the species. Another useful character is the spotting of the primaries, at least near base, with longitudinal series of red-brown dots. The pink secondary spines are also a noticeable character, those of the inter-ambulacra in these specimens being evidently tipped with yellowish. The large globiferous pedicellariae are very uncommon but are to

be found abactinally. The heads are less than a millimetre in length, but the stalk is nearly two millimetres; the latter has a conspicuous "limb," the branches of which are about .2 of a millimetre long. The valves resemble closely those of *T. affinis*. The tridentate pedicellariae are very slender, the valves, which are hardly .05 mm. wide, range from .9 to 1.25 mm. in length and meet only near tip. The small globiferous pedicellariae have valves ranging from .25 to .55 mm. in length and are provided with an end tooth.

Between Fremantle and Geraldton, W.A., 60-100 fms. Two specimens, No. 4,933.

The occurrence of this distinctly East Indian species off West Australia is notable and hardly to be expected. These large specimens bear a striking superficial resemblance to *Phyllacanthus annulifera*, but even hasty examination distinguishes them. The low collar and the red-brown spots, not to mention the pedicellariae, are sufficiently marked differences to be obvious to even a casual observer.

## GONIOCIDARIS TUBARIA.

*Cidarites tubaria*, Lamarck, 1816. Anim. s. Vert., vol. 3, p. 57.  
*Goniocidaris tubaria*, Lütken, 1864. Vid. Med. f, 1863, p. 137.

The occurrence of this species on the west coast is interesting, even though the specimens are small (20 mm. h.d.).

Between Fremantle and Geraldton, W.A., 100 fms. Two specimens, No. 4,938.

## CENTROSTEPHANUS TENUISPINUS,<sup>1</sup>

sp. nov.

PLATE XXVI.

This species is so nearly related to *C. rogersii* of New South Wales that an extended description would be superfluous. The test is essentially alike in the two species, but there are more coronal plates in the one from West Australia. The actinostome is noticeably smaller and the abactinal system is somewhat larger. Thus in an eastern specimen, 84 mm. h.d., there are 16 interambulacral plates in each column, the actinostome is 36 mm. across and the abactinal system is 18 mm., while in a western specimen of the same size, there are 18 interambulacral plates in each column, the

<sup>1</sup> GR. *tenuis* = slender + *spinus* = a spine.

actinostome is 32 mm. across and the abactinal system is 24 mm. When other adult specimens (*i.e.*, over 60 mm. L.d.) are taken into account, we find that these differences sum up to about this; in the eastern species the abactinal system is .50-.60 of the actinostome, while in the western form it is .65-.75. The most obvious character of the new species, however, is seen in its slender spines; the largest primaries are from 1.3 to 1.6 mm. in diameter where thickest (near base) and as they are 75-80 mm. long, they appear very slender as compared with *rodgersii*; in *rodgersii* the primaries are 2-3 mm. in diameter, at least near base, and seldom exceed 75 mm. in length. This difference in the primary spines gives the two species totally different facies. There is also a noticeable difference in colour, in the specimens I have seen, though it may not prove a constant one; in *rodgersii*, the colour is more or less purple, sometimes almost black, again deep crimson rarely brownish-red; in *tenuispinus*, the colour is reddish-brown or dull greenish, with no trace of purple.

The pedicellariae in the two species do not seem to differ except in relative frequency. Thus in specimens of *rodgersii*, slender tridentate pedicellariae seem to be very rare. Mortensen did not find them, and I have only found one on six specimens from New South Wales. But in *tenuispinus* they are very common all over the test and the valves may exceed 3 mm. in length. On the other hand, the stout tridentate pedicellariae with curved valves seem to be rather uncommon in *tenuispinus*.

Between Fremantle and Geraldton, W.A. Two specimens, No. 4,936. The light-coloured one is the Type.

It is of course possible that larger series of specimens than are available to me, will show that this supposedly new species is only a form of *rodgersii*, but the general appearance is so different, I have little hesitation in giving it a new name. And I am confirmed in this by finding that the specimens of *C. rodgersii* recorded by A. Agassiz (Rev. Ech. pt. 1, p. 98) from "Houtman's Abrolhos" are the slender spined western form and not typical *rodgersii*; at any rate this is true of the specimen in the M.C.Z. collection. This specimen is young (only 47 mm. h.d.) but when compared with a specimen from Port Jackson, 43 mm. h.d., its smaller actinostome and its much more slender primary spines are noticeable.

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SALMACIS ALEXANDRI.

Bell, 1885. Proc. Linn. Soc. N.S.W., vol. 9, p. 505.

A very fine specimen of this species is in the collection from off Geraldton, W.A., 29 fms., No. 4932. It is deep rose-purple, the spines tipped with white.

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## SALMACIS SPHAEROIDES.

*Echinus sphaeroides*, Linne, 1758. Sys. Nat. ed. 10, p. 664.

*Salmacris sphaeroides*, Lorén, 1887. Ech. Linn. p. 69.

There are two fine specimens (Nos. 4027 and 4028) from Port Hedland, W.A.; in one the test has a greenish cast and the bases of all the spines are conspicuously dark green, in the other the green colour is confined to the spine bases and is reduced to a minimum there; as a result of this seemingly slight difference the specimens look quite unlike.

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## TEMNOPLEURUS, sp. ?

There are a couple of bare tests of a temnopleurid (No. 5007) in the collection, with no data other than that they are from Fremantle Beach, West Australia, which cannot be referred to any known species. I think they undoubtedly represent a temnopleurus and probably an undescribed species, but I cannot see that anything is gained by giving them a name. They are 24 or 25 mm. h.d. and 13 or 14 v.d. The colour is dull green, with the median ambulacral and interambulacral areas cream-colour, gradually widening actinally, so that the whole lower surface is of that light shade. The base of one primary spine remains attached to the test, and it is pale red in colour. Until the spines and pedicellariae can be examined, this species may well be nameless.

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## AMBLYPNEUSTES GRANDIS.

H. L. Clark, 1912, Mem. M.C.Z., vol. 34, p. 329.

There is a single specimen (No. 4932) in the collection. It is about 60 h.d. and has lost most of its spines. It is from off Geraldton, 29 fms.



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AMBLYNEUSTES GRISEUS.

*Echinus griseus*, de Blainville, 1825. Dict. Sci. Nat. Oursin, vol. 37, p. 81.

*Amblyneustes griseus*, L. Agassiz, 1841. Intro. Mon. Scut., p. IX.

A rather small specimen (No. 5008) of this species is in the collection. From Fremantle Beach, W.A.

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HOLOPNEUSTES POROSISSIMUS.

L. Agassiz and Desor, 1846. Ann. Sci. Nat. (3) vol. 6, p. 364.

A specimen from Fremantle Beach, bearing the same number as the specimen of the preceding species from the same place (viz. 5008), proves to be one of this species.

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HELIOCIDARIS ARMIGERA.

*Strongylocentrotus armiger*, A. Agassiz, 1872. Bull. M.C.Z., vol. 3, p. 55.

*Heliocidaris armiger*, H. L. Clark, 1912. Mem. M.C.Z., vol. 34, p. 350.

Although the primary spines in these specimens are not quite so stout as in the type specimen, they are sufficiently so to distinguish them at a glance from their nearest ally, *H. erythrogramma*. None of the specimens is large (h.d. ranges 25-38 mm.) but all seem adult. The longest primaries do not exceed 15 mm., and their thickness is from 1.5 to 2 mm.

Fremantle Beach, W.A. One specimen, No. 5006.

Fremantle, W.A. One specimen, No. 149.

Cottesloe Beach, W.A. One specimen, No. 5036.

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HELIOCIDARIS ERYTHROGRAMMA.

*Echinus erythrogrammus*, Valenciennes, 1846. Voy. Venus., Zooph. pl. VII, fig. 1.

*Heliocidaris erythrogramma*, L. Agassiz and Desor, 1846 (3) Ann. Sci. Nat., vol. 6, p. 371 (*erythrogrammus* *lap. cal.*)

Although these specimens are a little larger than those of *armigera*, the spines do not exceed 15 mm. in length, but few of them are as much as 1 mm. in thickness, so that they seem longer than they are. There are no data with the two specimens, but they bear the numbers 171 and 179, and are said to be from West Australia.

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ECHINOMETRA MATHIAEI.

*Echinus mathaei*, de Blainville, 1825. Dict. Sci. Nat. Oursin, vol. 37, p. 94.

*Echinometra mathaei*, de Blainville, 1830. Dict. Sci. Nat., Zooph., vol. 60, p. 206.

The two specimens of this very common and widely distributed sea-urchin have no data with them. They bear the numbers 165 and 167 and are said to be from West Australia.

CLYPEASTER TELURUS,<sup>1</sup> sp. nov.

PLATE XXIII.

Test broadly oval, widest posteriorly, very flat, 96 mm. long, 89 mm. wide and 13 mm. high ; its breadth is thus nearly .93 of its length, while its height is less than .14. Test thin and fragile, its margin only 3 mm. thick. Abactinal system at centre of test, but the latter slopes more abruptly posterior to the apex than it does anteriorly or laterally. Posterior interradi al margin distinctly depressed below posterior radial margins. Lower surface slightly but very uniformly concave : the slope begins very near or at the margins and the mouth which is perfectly central, is nearly 4 mm. below (*i.e.* above, of course !) the lateral margins. Petaloid area 49 mm. long and 24 mm. wide. Anterior or unpaired petal 26 mm. long, 12 mm. wide, rather broadly open at distal end, the converging poriferous areas each about 2 mm. wide. Anterolateral petals 22 mm. long, 11 mm. wide, and nearly closed (open by 1 mm.) poriferous area about 2 mm. wide. Posterolateral petals 23 mm. long, 12 mm. wide, well open (by 3 mm.): poriferous area 2 mm. wide. Ridges between pore-pairs of unpaired petal, each with a single series of six or more primary tubercles. Median area of petals not at all abovate but as wide at middle as anywhere. Anal system, trigonal with rounded angles or oval, about 4.5 mm. broad by 3.75 mm. long ; its distal margin 10 mm. from distal margin of test, or more than .20 of the long radius. Madreporic body small, only 2.5 mm. across. Genital and ocular pores indistinguishable. Auricles well developed, well separated.

Abactinal primary spines very small. Scarcely a millimetre long, thickened at tip. Actinal primaries 3 mm. long (those about mouth 4 mm.) terete and bluntly pointed. Miliary spines minute and abundant, slightly thickened at tip. Pedicellariae rather scarce, except around mouth and anus where tridentate are fairly common. Valves of tridentate rather stout, the blades broad, meeting only at tip ; in the largest ones seen the valves are about .30 mm. long. Ophicephalous pedicellariae very scarce, small but not peculiar.

Colour of test, abactinally, dull purplish brown of a light shade ; actinally the test has a slight greenish cast ; abactinal spines under

<sup>1</sup> Gr. *telouros*—remote ; in reference to the unusual distance of the anal system from the margin of the test.

a lens, nearly white; actinal spines whitish, the largest ones with a faint broad band of purplish, near middle.

Between Fremantle and Geraldton, W.A. One specimen, No. 4937. Type.

This interesting new species is in many particulars like *C. rotundus*, A.Ag. from the west coast of Mexico and Central America, but there are some important differences. Chief of these is the position of the anus which in *rotundus* is rarely more than 3 mm. from the margin of the test. In *rotundus*, too, the poriferous areas of the petals are much wider in specimens of the same size; thus in a specimen of *rotundus* of the size of the *telurus* above described, the poriferous area would be about 3 mm. wide, or nearly 50% broader. The test is much more fragile and the margin is thinner in *telurus* than in *rotundus*.

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## PERONELLA APHNOSTINA<sup>1</sup> sp. nov.

### PLATE XXIV.

Test somewhat elongated, abruptly narrowed posterior to middle, very flat, finely and evenly granulated; length 137 mm.; greatest breadth, slightly anterior to mouth, 112 mm.; breadth equals less than .82 of length; 15 mm. back of mouth, width is only 95 mm. and 30 mm. back of mouth it is only 88 mm.; at anus, it is 55 mm. Apex of test coincides with centre of madreporic body, 64 mm. from anterior margin of test. Mouth directly beneath apex. Apical-oral diameter, 13 mm. Test thinnest at margin where it is scarcely 3 mm. thick. Oral surface flat; mouth scarcely at all sunken. Auricles fused into a single stout piece on each interambulacrum. Anal system small, about 4 mm. in diameter, its distal margin about 6 mm. from test margin; it is covered with small spine bearing plates.

Petaloid area, about 72 mm. long and 68 mm. broad. Anterior or unpaired petal, 36 mm. long; antero-lateral, 32 mm.; postero-lateral, 37 mm. Each petal is about 10 mm. wide. Unpaired petal broadly open (by 4.5 mm.); paired petals open by about 3 mm. Madreporic body about 4 mm. across. Genital pores 4, there being none in posterior interradians. Primary spines 3-4 mm. long actin-

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<sup>1</sup> GR.=*Aphno*, of a sudden + *steno*=to make narrow, in reference to the shape of the test.

ally, much smaller abactinally, terete, nearly smooth, those about mouth stoutest. Miliary spines minute, abundant, similar to those of *P. lesueurii*. Pedicellariae very scarce; the single tridentate that was found, was similar to those of *lesueurii*.

Colour abactinally, light reddish brown; the red is very marked when the test is moistened; actinally the colour is more yellow-brown.

Carnac Island, near Fremantle, W.A., Dec. 11, 1909. One specimen, No. 3936. Type.

I have been greatly in doubt as to whether this specimen represents a new species or is a peculiar individual variant of *P. lesueurii*, Agass. Comparison with numerous specimens from Queensland and from the East Indies has failed to satisfy my doubts, but as *lesueurii* has hitherto been found only on the eastern coast of Australia and does not reach so far south as Bass Strait, I have decided to give this West Australian specimen a new name indicative of its strikingly peculiar shape. Compared with a specimen of *lesueurii* from Queensland, of the same length, the following peculiarities are noted:—

1. The test is remarkably narrow; its greatest width is not much over 80 % of its length, while in *lesueurii* it is distinctly over 90 %.
2. The test is abruptly narrowed back of the mouth; its width 30 mm. back of mouth is less than 65 % of its length while it is more than 78 % in *lesueurii* at the same point.
3. The petals are shorter, wider and much more open at the tip; in *lesueurii* the petals are open only 1 mm. or less.
4. The test is thinnest at the margin; in *lesueurii* the test is a trifle swollen at the margin and is thinnest several millimetres proximal to margin.
5. The test seems to be more finely and uniformly granulated than in *lesueurii*.

While the last three of these characters are certainly more or less variable in *lesueurii*, and hence of doubtful value, the combination of the five in this Carnac Island specimen gives it a general appearance totally unlike that of any *Peronella* I have ever seen. The collection of a few more specimens on the West Australian coast would show whether *aphnostina* is a valid species or not.

## LINTHIA AUSTRALIS.

*Desoria australis*, Gray, 1851. Ann. Mag. Nat. Hist. (2), vol. 7, p. 132.

*Linthia australis*, A. Agassiz, 1872. Rev. Ech. pt. I, p. 138.

A single bare test (No. 5005) from Fremantle Beach shows that this is a West Australian species, although it was previously known only from South-western Australia and Tasmania. It is still a rarity in Museums and specimens with spines are greatly to be desired.

## ECHINOCARDIUM AUSTRALE.

Gray, 1851. Ann. Nat. Hist. (2), vol. 7, p. 131.

It is not at all surprising to find this widely distributed species in the collection.

Safety Bay, W.A. Three specimens, Nos. 239, 240, 241.

## BREYNIA AUSTRALASIAE.

*Spatangus australasiae*, Leach, 1815. Zool. Misc., vol. 2, p. 68.

*Breynia australasiae*, Gray, 1851. Ann. Mag. Nat. Hist. (2), vol. 7, p. 131.

The larger of these bare tests (No. 4562) measures 120 mm. long, by 100 mm. wide and 60 mm. high, showing that *Breynia* grows to a larger size than has hitherto been known. Although these specimens differ from those taken at Lord Howe Island, N.S.W., by the very characters on which Gray based his *Breynia desorii*, other specimens in the M.C.Z. collection are intermediate and I do not feel satisfied that *desorii* is a valid species.

Abrolhos Islands, W.A. One specimen, No. 4562.

Fremantle Beach, W.A. One specimen, No. 5004.

## HOLOTHURIOIDEA.

The holothurians unfortunately are not in nearly as good condition as the dry echinoderms, and it is impossible to identify one-third of them. They seem to have been in formalin and several are more or less decalcified. Nevertheless all are of interest for we have hitherto known almost nothing of the holothurians of the western half of Australia—indeed we know little enough of those of the eastern coast. Of the six identified species, three belong to the genus *Pentacta* (= *Colochirus*) and one of these seems to be a remarkable new species, which, should the characters shown by these specimens prove real and constant, might well be given a genus of its own. The other new species is an apodous holothurian of the genus *Caudina*.

CAUDINA TETRAPORA,<sup>1</sup> sp. nov.

Tentacles 15, each with 4 slender, sharply pointed digits, the terminal pair the longer. Calcareous ring well developed, about 2 mm. broad (high); posterior prolongations of radial pieces very conspicuous, nearly 4 mm. long. Stone-canal single, well-developed. Polian vessel single, long and cylindrical. Genital glands rather sparingly dichotomously branched. Respiratory-trees very fully developed. Body not very stout, passing gradually and not abruptly into the tail. The tip of the tail is damaged in both specimens, so the condition of the anal papillae could not be determined. Calcareous particles *knobbed buttons perforated with four holes*

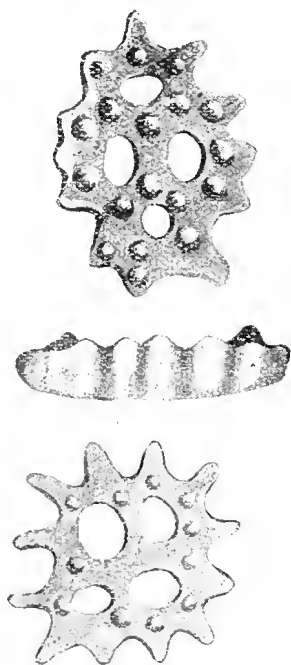
and with more or less conspicuous projections around the margin (text, fig. 1); they are about .1 of a millimetre long. Most of the particles are of comparatively regular form, but more or less variation from the typical condition may be noted; buttons with fewer than four holes are more frequent than those with more.

Colour white or pale brown. Length about 75 mm., of which about one-third is tail; diameter at middle of body 15 mm.: diameter near tip of tail, about 3 mm.

Cottesloe Beach, W.A., July 6, 1912. One specimen, No. 5035. Type.

Abrolhos Islands, W.A. One specimen, No. 229.

This species is readily distinguished from the other members of the genus by its perfectly distinctive calcareous particles. It is no doubt most nearly related to *C. chilensis*, the common New Zealand species, as might have been expected from its geographical propinquity.



TEXT-FIGURE 1.

Calcareous particles from body-wall of *Caudina tetrapora*. x 350.

- a. A typical button seen from the outer surface.
- b. A similar button from the side.
- t. A button with long marginal projections.

<sup>1</sup> GR. *Tetraporos* —having four pores, in reference to the calcareous particles of the skin.

## MOLPADIA, sp. ?

A specimen from Cottesloe Beach [No. 233 (2983)] is in such poor condition that its identification is impossible, but the stout calcareous ring with comparatively short posterior prolongations on the radial pieces is suggestive of Molpadia rather than Caudina, and the fifteen tentacles and absence of tube-feed, taken in connection with its general appearance, show that it is certainly a molpadid. The tail is missing: the remaining body measures about 40 mm. long by 17 in diameter.

## COLOCHIRUS QUADRANGULARIS.

*Holothuria quadrangularis*, Lesson, 1830. Cent. Zool., p. 90.

*Colochirus quadrangularis*, Selenka, 1868. Zeit. f.w.zool., vol. 18, p. 112.

A single specimen, well preserved and about 55 mm. long, but without data, other than "West Australia," is the sole representative of this species.

## COLOCHIRUS TUBERCULOSUS.

*Holothuria tuberculosa*, Quoy and Gaimard, 1833. Voy. de l'Astrolabe, Zool. vol. 4, p. 131.

*Colochirus tuberculosa*, Semper, 1868. Reis. Arch. Phil.: Holothurien, p. 239.

A specimen about 50 mm. long, and without other data than the simple "West Australia," represents this species.

COLOCHIRUS AXIOLOGUS,<sup>1</sup> sp. nov.

PLATE XXV.

Tentacles 10, large and arborescent, the two ventral ones much smaller than the other eight. Calcareous ring only moderately stout, about 3-4 mm. broad (high), with no posterior prolongations, Polian vessel single, rather large and nearly spherical. Stone-canal single, in the dorsal mesentery. Genital glands unbranched, 40-50 mm. long, in a thick tuft on each side of the mesentery, near the middle of the body cavity. Respiratory trees short, but well-developed and much branched. Ambulacral appendages nearly or quite confined to the ventral ambulacra; each of these ambulacra at the middle of the body carries about eight longitudinal series of well-formed, rather large pedicels, the entire band being about 10 mm. wide. As the ends of the body are approached, the series of

<sup>1</sup> Gr. *Axiologos*—remarkable.

pedicels rapidly, almost abruptly decrease to only four or three and then disappear altogether, so that there are no pedicels near either mouth or anus, even in the ventral ambulacra. Dorsal ambulacra (except to some extent near mouth) and all interambulacral areas, entirely free from pedicels or appendages of any kind. Body wall thick (in the type which has been preserved in alcohol, it is 2-3 mm thick) but entirely without calcareous deposits of any kind; a few minute calcareous rods are to be found in the finer branches of the tentacles, and the anus is guarded by five conspicuous calcareous teeth. Interambulacral areas somewhat pointed and projecting at both their anterior and posterior ends, forming valve-like folds which, in the contracted condition, conceal both mouth and anus.

Colour rose-purple, dull in the type and passing into brown on the tentacles, but rather bright in the other specimen, which might perhaps better be described as purplish-rose; in this specimen the tentacles are fully contracted and drawn into the body cavity and the neck-skin thus protected is bright purple, which is perhaps the natural colour of the entire animal in life.

The form of this species is notable and is better shown in the type, which is approximately 90 mm. long. The distance from mouth to anus along the mid-dorsal interambulacrum is however less than 70 mm. while along the mid-ventral ambulacrum it is 210 mm. The girth of the body is 190 mm.

Port Hedland, W.A. Two specimens, Nos. 4032 and 4033. No. 4033 is the Type.

It is difficult to decide whether the absence of calcareous particles in the body-wall is the natural condition or is due to decalcification. The type is so well preserved it is hard to believe it has been decalcified, but the other specimen was preserved in formalin and has the appearance of having been decalcified. If decalcification has occurred artificially it is hard to understand why the anal teeth and calcareous ring should persist apparently uninjured. On the other hand, the species of *Colochirus*, hitherto known, have an excessive amount of calcareous matter in the body-wall and its absence would therefore be an extraordinary specific character, should it prove to be natural and constant. The form of the body in these two specimens and the absence of pedicels on the dorsal surface are also extraordinary characters and should further



collecting produce additional specimens showing essentially the same combination of remarkable features, I should consider the species entitled to separate generic rank.

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### ACTINOPYGA MILIARIS.

*Holothuria miliaris*, Quoy and Gaimard, 1833 Voy. de l'Astrolabe, Zool., vol. 4, p. 137.

*Mülleria miliaris*, Brandt, 1835. Prod. Desc. Anim., p. 74 (et auct.)

Two large specimens (Nos. 218, 219) without data, except "West Australia," are in the collection. The generic name *Mülleria* has so often been shown to be preoccupied, so far as holothurians are concerned, there can be no justification for its further use instead of Brown's suggested substitute, *Actinopyga*.

---

### STICHOPUS, sp. ?

Three large holothurians (No. 4939) from between Fremantle and Geraldton seem to belong to the genus *Stichopus*, but they are so contracted and distorted and the body surface is so rubbed that it is impossible to determine them satisfactorily. They do not seem to be *S. variegatus* and I think they probably represent an undescribed species.

---

### HOLOTHURIA ATRA

Jaeger, 1833. De Holoth., p. 22.

These specimens which range from 100 mm. to 250 mm. in length seem to be identical with similar individuals from the Philippine Islands, and I see no reason to doubt that they are *atra*. There are no data with them but they are from "West Australia" and bear the Nos. 213, 215 and 216. Three specimens.

---

### HOLOTHURIA. sp. ?

There is a small, decalcified holothurian (No. 251) from "Pelsart Island, Abrolhos, W.A.," which unfortunately cannot be determined.

*Museum of Comparative Zoology,*  
*Cambridge, Mass., U.S.A.,*  
*June 1st, 1913.*

ON A COLLECTION OF  
REPTILES AND BATRACHIANS  
FROM WESTERN AUSTRALIA

By DENE B. FRY  
Junior Assistant, Australian Museum, Sydney.

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PLATES XXVII-XXVIII. AND TEXT FIGURES I-II.

In continuation of the arrangement with Mr. Bernard H. Woodward, Director of the Western Australian Museum, Perth, the Trustees have received a large collection of Reptiles and Batrachians from that State for identification. The present paper forms a report on those species contained which are of special interest, some being regarded as new, whilst others are re-described or recorded from Western Australia for the first time.

LACERTILIA (LIZARDS).

- Diplodactylus woodwardi*, sp. nov.  
„ *lucasi*, nom. nov.  
*Peropus variegata*, var. *punctata*, var. nov.  
*Ophioseps repens*, sp. nov.  
*Amphibolurus scutulatus*, Stirling and Zietz.  
*Egernia formosa*, sp. nov.  
*Lygosoma (Rhodona) picturatum*, sp. nov.  
*Cryptoblepharus rhodonoides*, L. & F.

OPHIDIA (SNAKES).

- Liasis olivaceus*, Gray?  
*Demansia psammophis*, var. *reticulata*, Gray.  
„ *modesta*, Günther.  
„ *affinis*, Günther.  
„ *nuchalis*, Günther.  
*Pseudechis australis*, Gray.  
*Furina bimaculata*, D. & B.

*BATRACHIA* (FROGS AND TOADS).*Limnodynastes ornatus*, Gray.,, *dorsalis*, Gray, var. *typica*.*Crinia georgiana*, Bilr., var. *stolata*, Cope.,, *leai*, Fletcher.*Phractops australis*, Gray.*Helioporus albopunctatus*, Gray.*Myobatrachus gouldii*, Gray.*Hyla caerulea*, White.,, *rubella*, Gray.,, *adelaidensis*, Gray.,, *latopalmata*, Günther.,, *nasuta*, Gray.

I wish to express my thanks to Mr. Woodward for his kindness in allowing me to examine this collection, and for undertaking the publication of my report.

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## LACERTILIA

(LIZARDS).

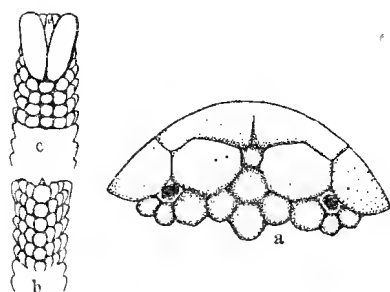
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### DIPLODACTYLUS WOODWARDI, Sp. nov.

PLATE XXVII., FIG. I. AND TEXT FIG. I.

Head elongate oviform, very convex, three-fourths as broad as long (the length of the head is measured from the tip of the snout to the ear opening). Snout rounded, one-third longer than the orbital diameter, as long as the distance between the eye and the ear orifice. Ear opening hardly distinguishable, very minute. Loreal region grooved; forehead not grooved. Rostral twice as broad as high, highest in the middle line where it is nicked; a small groove above, extending on the upper third of the rostral. Nostril situated between the first upper labial, a supranasal, and three small postnasals; supranasals separated from one another by two enlarged hexagonal granules; postnasal granules not enlarged; granules bordering supranasals enlarged, hexagonal. The posterior border of the upper eyelid (seen under a lens) bears six to seven small,

soft conical spines. Labials  $\frac{11}{11}$ , anterior largest. Mental longer than broad, broader in front than behind, slightly longer than the adjoining labials. Angle of the mouth slightly in front of the hinder border of the eye. A small fold from below the eye to



TEXT FIG. 1.—*Diplodactylus woodwardi*, sp. nov. (from type).

- a. Dorsal view of tip of snout, enlarged.
- b. Dorsal view of tip of fourth toe, enlarged.
- c. Ventral view of tip of fourth toe, enlarged.

behind the angle of the mouth ; another, possibly due to preservation, above the ear opening. Scales of head granular, very convex, uniform, those near the labials enlarged. Scales of back like those of the head, slightly larger than those of the sides. Belly scales flatter than dorsal scales, with a tendency, like those of the sides, to overlap. Scales of limbs uniform. Scales of tail squarish, larger than body scales, arranged in transverse rows. Digits cylindrical, not depressed at tips ; inferiorly with transversely oval granules ; two enlarged, elongate, slightly diverging plates at the apex.

**Colour** (Spirits):—Back light brownish, with eight or nine alternating darker brown bands consisting of a network enclosing occasional white spots. Large white spots on the sides between the bands. A band of reticulations on the loreal region and behind the eyes, connecting with its fellow in the occipital region. Upper surface of limbs with faint reticulations. Tail with alternating brown bands dorsally connected with each other laterally. Under surfaces uniform creamish.

Total length (from tip of snout to tip of tail) 51 mm.

This handsome species is allied to *D. alboguttatus*, Werner, <sup>1</sup>

<sup>1</sup> Werner.—Fauna Südwest-Austr., II, 1910, p. 462, fig. 4.

recently described from Denham on the Peron Peninsula, Shark Bay. The following short definition will distinguish the two species.

*D. alboguttatus*, Werner.

Snout a little longer than the distance of the eye from the ear opening. Ear opening obliquely elliptical. Rostral almost twice as broad as high, rectangular. Mental not longer than the adjoining labials. Nasal opening in contact with the rostral, one upper labial and four nasals, the upper (supranasals) in contact mesially.

*D. woodwardi*, sp. nov.

Snout as long as the distance between the eye and the ear opening. Ear very minute. Rostral twice as broad as high, roughly pentangular, nicked above. Mental slightly longer than the adjoining labials. Nasal opening not in contact with the rostral, and the supranasals are separate mesially by two hexagonal enlarged granules.

There are also colour differences which, however, are better shown by a comparison of the two figures.

**Locality.**—I have examined only a single young example from Western Australia.

**Type.**—In the W.A. Museum.

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## DIPLODACTYLUS LUCASI, nom. nov.

*Diplodactylus bilineatus*, Lucas and Frost, Proc. Roy. Soc. Vict., Ser. 2, XV., 1903, p. 146 (not *Diplodactylus bilineatus*, Gray, Cat. Liz. Brit. Mus., 1st ed., 1845, p. 149, and Zool. Erebus & Terror, Reptiles, pl. XV, fig. 3.)

The name *Diplodactylus bilineatus*, Lucas and Frost, is antedated by the same name proposed by Dr. J. E. Gray for a Gecko which Dr. Boulenger now regards as synonymous with *Phyllodactylus ocellatus*, Gray. As it becomes necessary to propose a new name for Messrs. Lucas and Frost's species, I have much pleasure in associating the name of Mr. A. H. S. Lucas with it.

It is worthy of remark that *Diplodactylus michaelsemi*, described and figured by Dr. Werner<sup>1</sup>, bears a general resemblance to Dr. Gray's figure of *Diplodactylus bilineatus*, but differs materially in structural characters.

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<sup>1</sup> Werner—Fauna Südwest-Austr., II, 1910, p. 460, fig. 4.

*Diplodactylus michaelsoni*, Werner, was described from Denham, while Messrs. Lucas and Frost's type of *D. bilineatus* came from Carnarvon. The type specimen of Dr. Gray's *D. bilineatus* (*Phyllodactylus ocellatus*, Gray, *vide* Boulenger<sup>1</sup>) was described from Houtman Abrolhos, and recorded by Dr. Günther<sup>2</sup> from Champion Bay, and by Dr. Werner<sup>3</sup> from Boorabbin, Coolgardie Goldfield.

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## PEROPUS VARIEGATUS, Dum. and Bibr., var. PUNCTATUS, var. nov.

*Gehyra variegata*, Gray, Lucas and Frost, Rep. "Horn" Sci. Exped. Centr. Austr., II, 1896, p. 124, pl. IX, fig. 3 (part only).

? *Gehyra variegata*, Gray, Werner, Fauna Südwest-Austr., II. 1910, p. 467 (part only).

In the collection is a single female example of this widely distributed species from the Strelley River, Pilbara. It presents the colour variety noted and figured by Messrs Lucas and Frost. In all structural characters it agrees with the variable *P. variegatus*, but the colour pattern is so different that I propose to distinguish it under the varietal name of *punctatus*. The following short diagnosis will serve to define this form.

Upper surfaces russet brown, lighter on the snout, with transverse rows of silvery and yellowish spots. The spots are more abundant on the limbs. Black spots may be distributed all over the dorsal surface or they may be confined to two rows, one each side of the vertebral column, between the rows of lighter spots. Sometimes two faint streaks of brown on the loreal region, the upper continuing behind the eye to above the ear opening.

---

## OPHIOSEPS REPENS, sp. nov.

TEXT FIGURES 2 AND 3.

Snout projecting, slightly hooked and trilobed; a little more than three times the diameter of the eye. Eye considerably longer than its distance from the mouth, surrounded by a ring of small scales, of which the posterior are the largest. Portion of the rostral seen from above is once and one half as long as its distance from the frontal, once and a quarter as broad as long, as long as the

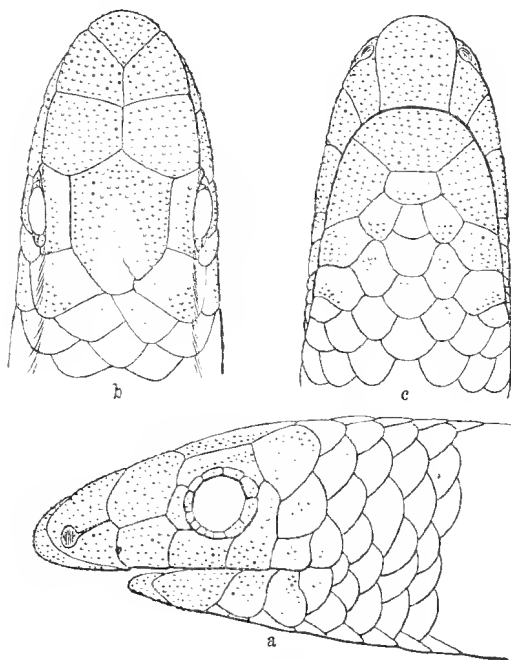
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<sup>1</sup> Boulenger—Brit. Mus. Cat. Liz., 2nd ed., I, 1885, p. 93.

<sup>2</sup> Günther—Ann. Mag. Nat. Hist., Ser. 3, XX, 1867, p. 49.

<sup>3</sup> Werner—*loc. cit.* p. 456.

diameter of the eye; the portion seen from below longer than broad and slightly narrower behind than in front. Nasals apparently fused with the first supralabial of each side, in contact behind the rostral; a little shorter than the praefrontals, their suture being the

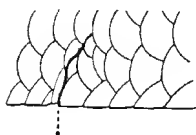


TEXT FIG. 2.—*Ophioseps repens*, sp. nov. From type.

- a. Side of head, enlarged.
- b. Dorsal view of head, enlarged.
- c. Ventral view of head, enlarged.

same length as that of the praefrontals. Nostril large, not visible from above; a very distinct groove runs from its posterior edge to the lower anterior border of the praefrontal. Praefrontals a little larger than the nasals, a little more than half the length of the frontal, forming a suture in the median line and with the first supralabial (the second supralabial if we count the first as fused with the nasal). Frontal six-sided; broader in front than behind; almost once and a half as long as broad, as long as its distance from the end of the snout. Supraocular narrow, extending down behind the eye and meeting the third supralabial. A pair of parietal shields larger than the adjoining scales, in contact behind the eye with the third supralabial. A small praeocular; no postocular.

Four supralabials distinct; the third very high and bandlike, in contact behind the eye with the supraocular and the parietal scale, the fourth smallest, squarish. Mental large, nearly twice as broad as long. Four sublabials, the anterior pair the largest and separated from each other in the median line by a small shield which is followed by three others, the middle one of which is the smallest. Headshields thickly dotted with minute papillae. Scales smooth,



TEXT FIG. 3.—*Ophioseps repens*, sp. nov. From type.  
Lateral view of anal cleft.

Typhlops-like, in twelve series round the body. Praeanals not enlarged. No external rudiments of limbs. Tail one third as long as the body, terminating in a circular scale.

**Colour** (Spirits):—Body light greyish brown above, slightly lighter beneath. Longitudinal rows of faint spots on the dorsal and lateral scales, these spots fainter and the rows more numerous on the sides. Headshields with faint brown marks. Tail yellowish, the rows of spots of a reddish colour.

Total length 145 mm., Tail 45 mm.

This new species is distinguished from *O. nasuta*, Bocage, mainly by the longer snout, which is hooked in profile; the much larger nostril and the presence of a very distinct groove which connects with the praefrontal, not with the first supralabial; the different proportions and shapes of the headshields, which in *O. repens* are covered with minute papillae, and the smaller number of scales round the body. The two species are here compared side by side.



<i>Ophioseps repens.</i>	<i>Ophioseps nasutus.</i>
1. Snout slightly hooked and trilobed: more than three times the diameter of the eye.	1. Snout not hooked, broadly rounded. Two and one half times the diameter of the eye.
2. Portion of the rostral visible from below longer than broad.	2. Portion of the rostral visible from below broader than long.
3. Nostril large, the groove connecting it with the praefrontal.	3. Nostril small, the groove, when present, connecting it with the first supralabial.
4. Praefrontals and nasals seen from above longer than broad.	4. Praefrontals and nasals seen from above much broader than long.
5. Frontal broader in front than behind, just as long as its distance from the tip of the snout.	5. Frontal broader behind than in front, more than twice as long as its distance from the tip of the snout.
6. Supraocular in contact with the third supralabial behind the eye.	6. Supraocular separated from the third supralabial by a postocular or several small scales.
7. Headshields with minute papillae.	7. Headshields quite smooth.
8. Scales in twelve series round the body.	8. Scales in fourteen series round the body.

Dr. Werner shows<sup>1</sup> that there is considerable variation in *O. nasuta*. In his *Aprasia brevirostris*<sup>2</sup> which he has later shown<sup>3</sup> to be synonymous with *O. nasuta*, the small scales which surround the eye are fused into a narrow band, and the portion of the rostral seen from above is sometimes half as long as its distance from the frontal while Jensen's figure<sup>4</sup> of *O. nasuta*, shows it to be almost as long as its distance from the frontal. The nasal cleft may be present or absent. In Jensen's specimens and in Du Bocage's type<sup>5</sup> there is a postocular, while in Dr. Werner's types of *A. brevirostris* there are two small undifferentiated scales behind the eye. The praeanales may or may not be enlarged.

This remarkable variation within the one species is only in keeping with the extraordinary individual variation of other members of the family Pygopodidae, to which family Dr. Werner has referred this genus. The above proposed new series however,

<sup>1</sup> Werner—Das Tierreich, Lief 33, 1912, p. 26.

<sup>2</sup> Werner—Fauna Süd.-Austr. II, 1909, p. 266, figs.

<sup>3</sup> Werner—Das Tierreich, Lief 33, 1912, p. 26.

<sup>4</sup> Jensen—Vid. Meddel., 1899, p. 317, pl. iii.

<sup>5</sup> Bocage—Jorn. Sc. Lisb., IV, 1873, p. 321.

differs too much to be considered a degree in variation of the type species, and in some respects is close to *Aprasia pulchella*, Gray.

**Locality.**—A single specimen from W.A. without exact locality is in the collection.

**Type.**—In the W.A. Museum.

## AMPHIBOLURUS SCUTULATUS, Stirl. & Zietz.

*Amphibolurus scutulatus*, Stirling & Zietz, Trans. Roy. Soc. S. Austr., XVI., 1893 p. 165, pl. VII., figs. 1 and 2.

Snout almost twice as long as the diameter of the eye opening, with projecting canthus rostralis and very concave lores. Nostril slightly nearer the eye than the tip of the snout, directed upwards and backwards, pierced in an enlarged nasal situated below the angle of the canthus rostralis. Rostral small, broader than long, roughly hexagonal. Tympanum large, vertically elliptic but slanting slightly forwards, its vertical diameter equal to that of the eye opening. Upper head scales sub-equal, smallest on the supra-orbital region, mostly tricarinate, the keels meeting at the posterior extremity of each scale. A superciliary ridge with elongate unicarinate scales. Scales much smaller on the temporal region. Scales bordering the upper lip, regular, not enlarged. A ridge of enlarged scales runs from beneath the eye to above the tympanum. Several small folds of skin on the neck bearing groups of small conical spines. Gular scales small, flat, sometimes faintly keeled, enlarged and hexagonal towards the lower labials. Mental longer than broad, slightly larger than the rostral. Scales of the upper surfaces strongly keeled, very slightly enlarged towards the vertebral region. A very distinct nuchal crest continuous behind with a vertebral series of slightly enlarged scales, or a distinct dorsal crest. Scales of limbs larger than body scales. Ventral scales keeled, larger than dorsal scales. Fore limb moderate; hind limb long, the toes of the adpressed limb reaching to the eye or the loreal region; the length of the foot equals that of the fore limb. The male with fifty to fifty-three praeanal and femoral pores forming an uninterrupted series on each side. Tail depressed at the base, with a serrated ridge not distinguishable on the posterior third of its length.

**Colour (Spirits):**—Upper surface of head rusty brown with black spots on the keels of the scales. Sides of head lighter, shading to yellow, sometimes with several fine black temporal streaks. A single median series of large black spots on the neck and anterior part of the back, breaking up into a double series of dorso-lateral spots towards the posterior part of the body. These spots sometimes enclose (towards the posterior part of the body) a light area of yellowish or brownish with a variegated centre. External to this series of spots is a light reddish, dark-edged band of lozenge-shaped spots, or a series of definite dark-centred light-edged ocelli. A series of about six narrow, light ashy-grey transverse bars cross the back, dividing the ocelli or separating the lozenge-shaped spots. Sides yellowish, reticulated with greyish or black. Tail sometimes with a distinct lateral band of lozenge-shaped spots and a light dorsal band, or variegated brownish. Numerous light ashy-grey bands cross the tail, completely dividing the dark lateral band. Under surfaces uniform yellowish, or more or less densely clouded with black on the throat, chest and abdomen. Limbs reddish-brown with yellow lines enclosing more or less regular shaped spots. Under surfaces sometimes clouded with black. Feet and hands rusty-red.

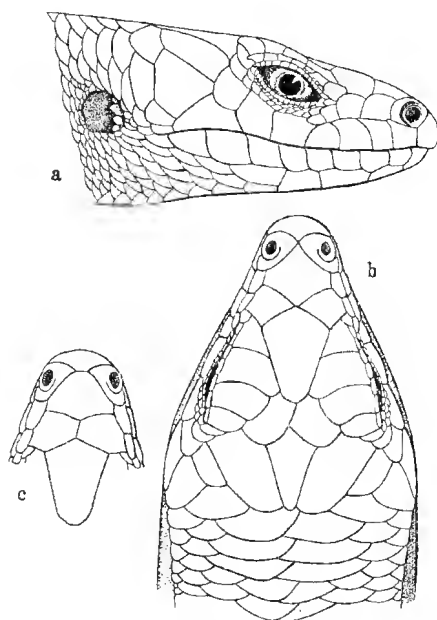
The affinities of this lizard are with *A. cristatus*, Gray, and the differences have been summed up by Messrs. Stirling and Zietz as follows:—"All the scales are much smaller, the head scales not rugose as in *A. cristatus*, but smooth and strongly keeled. The dorsal scales are not intermixed with larger ones, but increase in size towards the vertebral line. The compressed spines of the nuchal crest are shorter." To these might be added the marked difference in colour marking. Recorded from between Fraser Range and Queen Victoria Springs.

**Localities.**—A single adult female from Mt. Malcolm is in the collection. I have also examined a specimen presented to the Australian Museum by Mr. A. H. S. Lucas, from Kalgoorlie. Both these and the original description have been utilised in the preparation of the above description.

## EGERNIA FORMOSA, sp. nov.

PLATE XXVII, FIG. 2 AND TEXT FIG. 4.

Head rather broad. Head shields smooth. Rostral once and a half as high as broad, pentagonal, forming an arcuate suture with each nasal. Nasals slightly swollen, separated or just in contact with the rostral. A curved groove behind the nostril. Frontonasal slightly broader than long. Praefrontals moderate, forming a short median suture or just separated by the frontal. Frontal once and a third to once and a half as broad as long, separated from, or narrowly in contact with, the frontonasal; in contact with the first and second supraoculars. Four supraoculars, second largest; six to eight supraciliaries. A group of imbricate prae- and postoculars. Frontoparietals forming a median suture; in contact with the second, third and fourth supraoculars. Interparietal almost twice as long as broad, as long as or longer than the frontal. Parietals separated by the interparietal. Three pairs of enlarged nuchals



TEXT FIG. 4.—*Egernia formosa*, sp. nov.

- a. Side view of head, enlarged.
- b. Dorsal view of head, enlarged.
- c. Tip of snout of a specimen showing variation in shields

normally. Labials  $\frac{7}{7}$  or  $\frac{7}{8}$ , the seventh upper and the seventh lower largest, the fifth and sixth below the orbit. Three enlarged temporals. Ear opening oval, with two to four projecting lobules anteriorly, its vertical diameter almost as long as the eye opening. Twenty-eight smooth or feebly straited scales round the body, those on the vertebral line slightly enlarged, those on the sides smallest. Praeanals not or but feebly enlarged. Limbs moderate; when adpressed they just meet or slightly overlap. Toes slender, compressed; eighteen to twenty lamellae under the fourth. Tail cylindrical or very slightly depressed at the base, a little longer than the head and body; no series of transverse scales dorsally except in reproduced portions.

**Colour** (Spirits):—Dark or yellowish olive above. Head shields with irregular dark brown markings. Two dark brown bands which sometimes coalesce, start on the parietals and extend on to the back, where they break up into spots. Numerous transversely arranged yellow spots on the back and tail. A dark brown band starts on the loreal region and extends on to the side where it breaks up into spots. Labials yellow, sometimes barred with brown. Throat reticulated with brown. Under surfaces uniform yellowish.

Length of largest specimen, from snout to vent, 95 mm.

*Egernia formosa* has the general appearance of *E. striolata*,<sup>1</sup> Peters, but in reality is widely separated from that species. In Dr. Werner's key<sup>2</sup> to the species of the genus *Egernia* it must be placed in the division I. A., the species of which are characterised by the cylindrical tail and the smooth scales. Of the five species in this division it shows affinity with the first two only, *Egernia luctuosa*, Peters<sup>3</sup> and *E. lauta*, de Vis.<sup>4</sup> From the former it is distinguished by the presence of a curved groove behind the nostril and in having twenty-eight scales round the body; from *E. lauta* it also differs by the possession of a post-narial groove, while there are no infraoculars in *E. formosa* and much longer limbs.

The separation of the palatine bones by the palatal notch is characteristic of *Egernia*.<sup>5</sup> Though this condition is maintained in all my specimens yet the fleshy intergument covering them over-reaches their edges so that they appear to be in contact in the median line.

<sup>1</sup> Peters—Mon. Berl. Acad., 1870, p. 642 (*Tropidolepisma striolatum*).

<sup>2</sup> Werner—Fauna Südwest-Austr., II, 1910, p. 472.

<sup>3</sup> Peters—loc. cit. 1866, p. 90 (*Cyclodus* [*Omolepida*] *luctuosus*).

<sup>4</sup> de Vis—Proc. Linn. Soc., N.S.W., 2nd ser., II, 1887, p. 813.

<sup>5</sup> Boulenger—Brit. Mus. Cat. Liz., 2nd ed., III, 1887, p. 134.

I have also found the same structure in *E. striolata* and *E. whitei*. A knife passed between the fleshy lobes, however, shows the true condition of the bones.

**Localities.**—Eight specimens are before me, six adults and two young. The Type, together with three other specimens, was presented to the Trustees of the Australian Museum by Mr. W. D. Campbell, who collected them at Perth. There are also three other specimens collected by the same gentleman at Boulder. A single specimen, figured on Pl. XXVII, Fig. 2, and Text Fig. 4, is in the Collection forwarded by Mr. Woodward, but is unfortunately without data.

**Type:**—In the Australian Museum, Sydney. Reg. No. R. 3058. A co-type is deposited in the Western Australian Museum

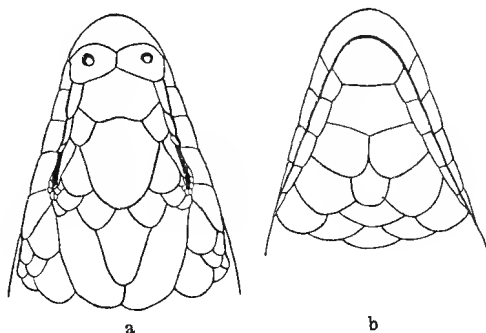
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## LYGOSOMA (RHODONA) PICTURATUM, sp. nov.

PLATE XXVII. FIG. 3, AND TEXT FIGURE 5.

Head small, sub-cuneiform. Snout rounded, acutely produced in profile, three to four times as long as the orbital diameter, with a slightly projecting labial ridge. Eye small; the lower eyelid with a transparent disc. Ear visible, minute, but generally covered with scales. Rostral twice as broad as high, highest in the mid-line; forming an arcuate suture with each nasal. Nostril pierced in the centre of a large swollen nasal which forms a moderate suture with its fellow. Fronto-nasal once and one-quarter to once and three-quarters as broad as long, forming a broad, curved suture with the frontal. Praefrontals small and widely separated; sometimes united with the posterior loreal and in contact with the second and third, or the third upper labial. Frontal large, much broader than the supraocular region; a little longer than broad; almost as long as its distance from the end of the snout; in contact with the first supraocular. Supraoculars two, first much the larger. Three or four supraciliaries, the first one sometimes very long. Upper eyelid represented by a row of very small inbricate scales between the supraciliaries and the orbit. A group of small, irregular prae- and postocular scales. Frontoparietals separated by the interparietal; about as large as the first supraocular, larger than the praefrontals. Interparietal moderate, narrowly in contact

with the frontal. Parietals rather narrow, forming a suture behind the interparietal. Two to four pairs of indefinitely enlarged nuchals. Temporal shields three, the two bordering the parietals large.



TEXT FIG. 5.—*Lygosoma (Rhodona) picturatum*, sp. nov.

a. Dorsal view of head, enlarged.

b. Ventral view of head, enlarged.

Labials  $\frac{6}{6}$ , the fourth upper entering the orbit, the fifth largest. Two elongate loreal shields, one, the posterior, sometimes united with the praefrontal. Eighteen to twenty polished scales round the body. Praeanals distinctly enlarged. Fore limbs very minute, represented by a scarcely visible papilla situated in a depression, or by a styli-form rudiment which may be as long as the eye. Hind limbs didactyle as long as, or nearly as long, as the distance between the eye and the fore limb; contained almost four, to nearly five times in the distance between the axilla and the groin. Toes compressed; twelve to fourteen lamellae under the longest. Tail as thick as the body.

**Colour (Spirits):**—Buff-coloured above. Head shields edged with brown. Two to four rows of spots confluent into distinct lines on the back and tail. A dark brown lateral band runs from the nostril, along the side, to the end of the tail. Uniform yellowish beneath.

Length of largest specimen, from snout to vent, 92 mm.

This species presents two more or less distinct varieties which may be separated as follows:—

Variety A (typical form).—Rows of spots forming four lines down the back. Fore limb a distinct styli-form rudiment at least as long as the eye. Twenty scales round the body.

Variety B.—Only two distinct lines down the back. Fore limb represented by a minute papilla, situated in a small depression, below the general surface. Eighteen to twenty scales round the body.

*Lygosoma picturatum* is allied to *L. gerrardi*, Gray,<sup>1</sup> but also appears to possess affinities with *L. walkeri*, Blgr.<sup>2</sup> The three species may be distinguished as follows:—

*Lygosoma gerrardi*, Gray.

Three supraoculars, second largest. Five supraciliaries. Frontoparietals distinct. Yellowish above with a dark lateral and a broad dorsal band.

*Lygosoma picturatum*, sp. nov.

Two supraoculars, the first much the larger. Three or four supraciliaries. Frontoparietals distinct. Buff coloured above, with a dark lateral band and two to four rows of spots confluent into lines on the back and tail.

*Lygosoma walkeri*, Blgr.

Three supraoculars, second largest. Five supraciliaries. Frontoparietals fused into a single shield. Greyish above, each scale with a black dot, which is largest on the fourth scale from the mid-dorsal line.

**Localities.**—I have examined nine specimens of this new species. Two, including the Type, were presented to the Trustees of the Australian Museum by Mr. W. D. Campbell, who collected them at Boulder. A third specimen was collected by the same gentleman at Perth. Five other specimens are without locality, and differ somewhat from the typical form in having only two lines down the back. In the collection forwarded by Mr. Woodward is a single large specimen, figured on Plate XXVII, fig. 3, and Text fig. 5. This specimen is unfortunately without data.

**Type.**—In the Australian Museum at Sydney, Reg. No. R. 3101. A co-type is in the W.A. Museum.

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<sup>1</sup> Boulenger—Brit. Mus. Cat. Liz., 2nd ed., III, 1887, p. 335, pl. XXVII, fig. 3.

<sup>2</sup> Boulenger—Ann. Mag. Nat. Hist. (6), VIII, 1891, p. 405.



## CRYPTOBLEPHARUS RHODONOIDES. L. &amp; F.

*Ablepharus rhodonoides*, Lucas and Frost, Proc. Linn. Soc. N.S. Wales, XXI., 1896, p. 281.

? *Ablepharus distinguendus*, Werner, Faun. Südwest. Austr., II., 1901, p. 490.

The resemblance between this small *Cryptoblepharus* and *Lygosoma* (*Rhodona*) *fragile*, Günther, is very striking indeed, rendering the specific name proposed for it by Messrs. Lucas and Frost a very appropriate one. It was originally described from Mildura, a township on the Victorian side of the Murray River. I am now able to extend its range to both Western Australia and New South Wales. In the Western Australian Collection is a specimen from the Strelley River. The Australian Museum Collection contains numerous specimens from the following localities:—Perth and Boulder, Western Australia; Mildura, on the Murray River, Victoria (one of the types); Darling River, Moloch, Bindogmidra and Narramine, on the Western Plains of New South Wales.

A careful examination of all my specimens shows that this species is not a variable one, indeed I can find no point in which they differ from the original description, or from the co-type specimen in the Australian Museum.

It seems to me very probable that the scink described by Dr. Werner as *Ablepharus distinguendus* really belongs to this species. Dr. Werner's description is very meagre however, and I cannot be sure of this. The only difference that I can detect is in the number of scale rows, which in his new species are eighteen in number whereas in all my specimens of *C. rhodonoides* they are in twenty. *A. distinguendus* is stated to be very closely allied to *Cryptoblepharus muelleri*, Fischer, with which species Messrs. Lucas and Frost also compare *C. rhodonoides*.

## OPHIDIA.

(SNAKES.)

## LIASIS OLIVACEUS, Gray ?

*Liasis olivaceus* (Gray), Boulenger, Brit. Mus. Cat. Sn., I., 1893, p. 79, pl. IV., fig. 2.

There is a large skin in the collection which differs so much from Boulenger's description that it should perhaps be regarded as a distinct species. With our limited knowledge of the variations of this snake however it is safer to merely record these variations and await additional material. The differences will be seen from the following table.

<i>L. olivaceus.</i>	<i>L. olivaceus. ?</i>
V. 349-361.	V. 357.
S. C. 100-102.	S.C. 101.
Scales in 69-75 rows.	Scales in 56-64 rows.
Labials $\frac{13}{18}$ $\frac{15}{18}$	Labials $\frac{11}{18}$ .
Rostral broader than high.	Rostral higher than broad.
Eye larger than its distance from the mouth.	Eye smaller than its distance from the mouth.
Frontal $1\frac{1}{2}$ as long as broad.	Frontal $1\frac{1}{4}$ as long as broad.
A small azygous shield (often absent) separates the praefrontals.	A large well defined six-sided azygous shield separates the praefrontals.
Internasals more than half as long as anterior praefrontals.	Internasals half as long as anterior praefrontals.

There are five lower labials pitted, the pits being decidedly stronger than those figured by Boulenger. The parietals are in contact behind the frontal and are considerably larger than he shows them.

## DEMANSIA, Gray.

*Demansia*, Gray, Zool. Miscell., 1842, p. 54 (for *Elaps psammophis*, Schleg.)  
*Diemansia*, Günther, Cat. Col. Sn., 1858, p. 254.  
*Diemenia*, Günther, Ann. Mag. Nat. Hist., (3), XII., 1863, p. 350. *et auctorum*.

The generic name *Diemenia* used by recent authors is untenable. It was originally spelt *Demansia* by Dr. Gray but was

afterwards altered to *Diemansia* and *Diemenia* by Dr. Günther. *Diemenia* has been used by all recent authors but the name as originally spelt must be used.

The following pages include descriptions and notes on the Western Australian species of the genus, based on the material forwarded by Mr. Woodward together with numerous specimens in the collection of the Australian Museum.

Key to the Western Australian species of *Demansia*.

A. Scales in fifteen rows.....*D. psammophis* var. *reticulata*, Gray.

B. Scales in seventeen rows.

c. Portion of rostral visible from above measuring about half its distance from the frontal. V. 154-178, S.c. 38-51 pairs.....*D. modesta*, Günther, p.

cc. Portion of rostral visible from above about three quarters as long as its distance from the frontal. Snout broadly rounded. Head with brown smudges; back with scattered brown spots. V. 215-225, S.c. 52-63 pairs, *D. affinis*, Günther, p.

ccc. Portion of rostral visible from above as long as its distance from the frontal. Head tapering, sides nearly straight, snout more or less truncate. V. 184-224, S.c. 49-66 pairs.....*D. nuchalis*, Günther, p.

## DEMANSIA PSAMMOPHIS, Schl., var. *reticulata*, Gray.

*Diemenia psammophis*, var. *reticulata*, Boulenger, Cat. Sn. Brit. Mus. III., 1896, p. 323.

*Diemenia reticulata*, Lucas and Frost, Rept. "Horn" Sci. Expdn., II., 1896, p. 147.

*Diemenia psammophis*, Werner, Fauna Südwest-Austr., II., 1909, p. 257.

Scales 15 rows on anterior half, 13 on posterior half of body. Oc. 1 + 2 or 3. Temp. 2 + 2. V. 176-197. S.c. 65-79 pairs

Several specimens of var. *reticulata* are in the collection. They are all a light olive with a very distinct reticulated pattern. The hinder third of the body is somewhat lighter, shading to yellowish brown at the tip of the tail. A black, yellow edged, streak passes from eye to eye round the rostral, and another larger one beneath the eye passes obliquely downwards and backwards. A yellow spot on the preocular; labials yellow. Yellowish or creamy white beneath

**Localities.**—This well marked variety is confined to Central and Western Australia. Messrs. Lucas and Frost record it from Alice Springs and Charlotte Waters, Central Australia, and Dr. Werner from Northam, W.A. In the Australian Museum are specimens from Perth and Strelley River, Pilbara. Several specimens of *D. psammophis* from Bourke and Moree, western N.S.W., belong to the typical variety, while one from North Australia is the form described by Macleay as *D. papuensis*.

### DEMANSIA MODESTA, Günther.

*Cacophis modesta*, Günther, Ann. Mag. Nat. Hist. (4), IX, 1872, p. 35, pl. III, fig. C.

*Furina ramsayi*, Macleay, Proc. Linn. Soc. N.S.W., X, 1885, p. 61.

„ „ Lucas and Frost, Rept. "Horn" Sci. Expdn., II, 1896, p. 149.

? *Brachysoma sutherlandi*, de Vis, Proc. Roy. Soc. Q'land., I, 1884, p. 139.

? *Pseudelaps sutherlandi*, Boulenger, Cat. Sn. Brit. Mus., III, 1896, p. 320.

? *Pseudelaps sutherlandi*, Longman, Mem. Q'land. Mus., I, 1912, p. 24.

*Diemenia modesta*, Boulenger, Cat. Sn. Brit. Mus., III, 1896, p. 320.

Scales 17 rows. Temp. 1 + 1 or 2, V. 154-178, S.c. 38-51 pairs.

This species is at once distinguished from its congeners, *D. textilis* and *D. affinis*, by its smaller number of ventral and subcaudal plates. In the specimens before me, all of which are young, the dark cross bands vary considerably according to the age of the specimen. They become indistinct, in some cases quite obsolete, at a somewhat earlier stage than do the bands in young examples of *D. textilis*. I have not seen any fully adult examples of this species, but, judging from Dr. Boulenger's description, the cross bands in some specimens remain throughout life, as in exceptional cases in *D. textilis*.

I have examined the three specimens from Milparinka, western N.S.W., labelled types of *Furina ramsayi*, Macleay, and find they are identical with the young of *D. modesta*. There are some discrepancies in Macleay's description. According to that author the ventrals are 162 and the subcaudals 38 pairs in the largest specimen, whereas I find them to be 178 and 43 pairs respectively. In the second largest specimen they read V. 165, S.c. 49 pairs, and in the smallest, V. 169?, and S.c. 45 pairs. In the latter specimen, which is apparently just hatched, the frontal is twice as broad as the supraocular, and proportionately large. This feature I have observed in very young snakes of other species.

**Localities.**--*D. modesta*, Günther, is recorded from the following localities :—Perth ; the North-West (types, Günther, 1872, and Boulenger, 1896) ; Geraldton (Boulenger, 1896), Milparinka, Barrier Range, Western N.S.W. (types of *Furina ramsayi*, Macleay, Austr. Mus.) ; Crown Point, Horse Shoe Bend, Finke River, Central Australia (Lucas and Frost, 1896) ; Norman River, North Queensland (types of *Brachysoma sutherlandi*, de Vis, 1884, Q'land. Mus.) ; Lawlers and Boulder, W.A. (Austr. Mus.).

## DEMANSIA TEXTILIS, D. & B.

*Diemenia textilis*, Boulenger, Cat. Sn. Brit. Mus., III., 1896, p. 325.

Although there are several mentions of *D. textilis* occurring all over Australia, I know of no authentic record of its occurrence in Western Australia. Krefft<sup>1</sup> gives "Australia generally" as the habitat of *Diemenia superciliosa*, as it was then called. Again he says,<sup>2</sup>—"A species which . . . ranges from the East to the West Coast, and perhaps extends all over the whole continent." Speaking of *D. nuchalis*, Waite<sup>3</sup> is of the opinion that "it is possible that the Brown Snakes (*D. textilis*) recorded from Western Australia are referable to this species."

## DEMANSIA AFFINIS, Günther.

PLATE XXVII, FIG. 4, AND TEXT FIG. 6A.

*Pseudonaja affinis*, Günther, Ann. Mag. Nat. Hist., (4), IX, 1872, p. 35, pl. IV, fig. C.  
 " " Macleay, Proc. Linn. Soc. N.S.W., II, 1878, p. 29.  
 " " Lucas and Frost, Rept. "Horn" Sci. Expdn., II, 1896, p. 148,  
*Diemenia nuchalis* (part), Boulenger, Cat. Sn. Brit. Mus., III, 1896, p. 326.

Head broad ; snout not truncate but broadly rounded. Eye moderate. Rostral broader than deep, the portion visible from above almost as long as its distance from the frontal ; internasals two-thirds to four-fifths the length of the prefrontals ; frontal broader than the supraocular, once and a half as long as broad two-thirds the length of the parietals ; nasal entire or semi-divided. Two or three postoculars ; temporals 1 + 2. Six upper labials, last very large, third and fourth entering the eye. Scales in seventeen to twenty-one rows. V. 215-225. S.c. 52-63 pairs.

<sup>1</sup> Krefft—Austr. Vertebr., Foss. and Recent, Sydney, Feb. 1871, p. 54.

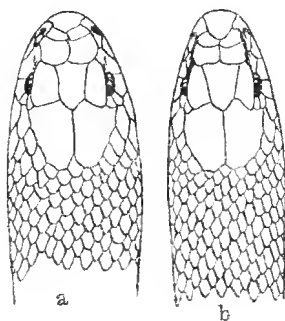
<sup>2</sup> Krefft—Vertebr. Lower Murray, 1865, p. 31.

<sup>3</sup> Waite—Australian Snakes, 1898, p. 51.

**Colour** (Spirits):—Uniform brownish above, lighter on the head and the sides. Head with dirty smudges and a few scattered, irregularly placed dark brown spots. Sides and back with irregularly distributed, more or less abundant dark brown spots, which in many cases exactly cover one scale. Under surfaces uniform yellowish olive, or finely peppered with grey. Throat yellowish or dark bluish grey.

Total length of largest specimen, 1525 mm., tail, 250 mm.

I have examined four specimens of this *Demansia* and think it will prove constantly distinct from *D. nuchalis*. After examining Dr. Günther's type specimen Dr. Boulenger placed this species in the synonymy of *D. nuchalis*, possibly regarding such slight differences founded on a single specimen as not of specific value. With four additional specimens at hand however, all of which differ in the same characters from *D. nuchalis*, I propose to raise *D. affinis* to specific rank. When placed side by side the two forms appear



TEXT FIG. 6.

- a. *Demansia affinis*, Gthr.  
(After Günther, from type specimen, reduced.)
- b. *Demansia nuchalis*, Gthr.  
(After Günther, reduced.)

strikingly different, but a closer examination shows that the differences are mainly in the general appearance, the outline of the head (see Text figs. 6a and 6b), and the colouration. Also, Messrs. Lucas and Frost record a specimen in which the scales are in twenty-one rows, the greatest number recorded for the genus.

**Localities.**—*Demansia affinis* is known from the following localities:—Australia (type, Günther, 1872). Reedy Creek, George

Gill Range, Central Australia (Lucas and Frost, 1896). Western Australia (W. A. Mus.); S.W. Australia (Austr. Mus.) King George Sound (Macleay Mus.)

## DEMANSIA NUCHALIS, Günther.

(Fig. 6b.)

- Pseudonaja nuchalis*, Günther, Cat. Col. Sn., 1858, p. 227.  
 " " Günther, Proc. Zool. Soc., 1863, p. 17, fig.  
 " " McCoy, Ann. Mag. Nat. Hist., (3), XX., 1867, p. 182.  
 " " Krefft, Sn. Austr., 1869, p. 44, pl. XII., fig. 13.  
 " " Macleay, Proc. Linn. Soc., N.S.W., II., 1878, p. 219.  
 " " de Vis, Proc. Roy. Soc. Q'land., I., 1884, p. 58.  
 " " Lucas and Frost, Rept. "Horn" Expdn., II., 1896, p. 148.  
*Diemenia aspidorhyncha*, McCoy, Prodr. Zool. Vic., 3., 1879, p. 13, pl. XXIII., fig. 4.  
*Diemenia nuchalis*, Boulenger, Cat. Sn. Brit. Mus., III., 1896, p. 326.  
 " " Werner, Fauna Südwest-Austr., II., 1909, p. 257.  
*Pseudelaps bancrofti*, de Vis, Ann. Q'land. Mus. X., 1911, p. 25.  
 " " Longman, Mem. Q'land. Mus., I., 1912, p. 24.

Head tapering and truncate at the snout, the sides almost straight in the adult but somewhat curved in the young. Eye moderate. Rostral broader than deep, the portion visible from above may be a little longer than its distance from the frontal or not quite as long; internasals shorter than the prefrontals; frontal considerably broader than the supraocular, once and a half to almost twice as long as broad, a little shorter to a little longer than its distance from the tip of the snout, two-thirds to four-fifths the length of the parietals. Nasal entire or semi-divided, in contact with a single praeocular two or three postoculars; temporals 1 + 2 or 3; six upper labials, third and fourth entering the eye, sixth very large. Scales in seventeen to nineteen rows. V. 184-224; anal divided; S.c. 49-66 pairs.

### Colour (Spirits):—

- Var. A. Body uniform light or dark brown above. A. nuchal collar may be present. Under surfaces greenish grey or yellowish; throat slightly darker. A melanotic form, in which the head, neck and anterior parts of the body are rich brown or black, occurs in this variety.  
 (Vars. A. and C. of Lucas and Frost; vars. A. and B. part only? of Boulenger; vars. I, II, III of Werner.)

Var. B. Body light or dark brownish above, variegated with black or dark brown. The scales may be edged with darker (edged with lighter according to McCoy in *D. aspidorhyncha*), or there may be bands of darker colour or zig-zag lines of dark brown. These markings, if not confined to the posterior two-thirds of the body are most distinct in that region. One or two black nuchal bands are rarely present. Ventrals olive, greyish or yellowish, uniform or with round dark spots on those of the posterior moiety. Throat sometimes peppered with grey.

A melanotic form also occurs in this variety. (Vars. B. and E. of Lucas and Frost; var. B. part only? of Boulenger; vars. IV and V of Werner).

Total length of largest specimen (Kreff), 1600 mm., tail 300 mm.

*Demansia nuchalis* is an extremely variable species both in colouration and in structural characters. The youngest specimen I have seen is sixteen inches in length, in which the colouration is like that of some of the adult specimens. This suggests that the young of this species, unlike the young of *D. textilis*, and *D. modesta*, may not have distinct black bands round the body. I have examined two melanotic specimens which do not otherwise differ from the typical form, and, as this form is present in both varieties it would appear to be quite sporadic in its occurrence.

**Localities.**—This species is known from the following localities:—Swan River and Geraldton; North-Western Australia; Port Essington, Northern Territory (Boulenger, 1896); Edel Land, Baba Head and Rottneet Island, W.A. (Werner, 1909); Alice Springs and between Laurie's Creek and Glen Edith, Central Australia (Lucas and Frost, 1896); Port Darwin, Northern Territory (Macleay, 1878); Stannary Hills, Central Eastern Queensland (de Vis, 1911, as *Pseudelaps bancrofti*). In the Australian Museum are specimens from Perth, 80 miles south of Perth, and Beverley, W.A.; Hermidale, near Nyngan, Western N.S.W., and Yandembah, Riverina, N.S.W.



## PSEUDECHIS AUSTRALIS, Gray.

A very large specimen is in the collection which is of interest as the characters exhibited show an overlapping between *P. denisonioides*, Werner<sup>1</sup> and *P. australis*, Gray. The ventrals are 189 and the subcaudals  $40 + \frac{14}{13}$  (54 in all), thus agreeing almost exactly with the scaling of *P. denisonioides*, V. 189, S.c.  $34 + \frac{19}{9} + 1$ , (54 in all). In *P. denisonioides* the internasals are one-third as long as the praefrontal, a condition exhibited by none of the specimens of *P. australis* that I have seen. The frontal is half as long as the parietal in Werner's new species, but in my specimen it is only three-fifths as long, the normal for *P. australis* being two-thirds the length of the parietals. Other differences in Werner's species are a single anal and the greater extension of the rostral on the dorsal surface of the snout.

I have examined a number of specimens of *P. australis* and find that this species varies very considerably. *P. denisonioides*, however, differs so much that the above could not be regarded as uniting the two species, but shows at least that the scaling overlaps.

The scale formulae of *P. australis* should now stand:—V. 189-220; Anal 2, S.c. 8-41 single + 14-54 paired. Total 53-70. Temporals 1-2 + 2.

## FURINA BIMACULATA, D. and B.

TEXT FIG. 7.

*Furina bimaculata*, Dum. and Bibr., Erp. Gen., VII, 1854, p. 1240.

" " Jan., Rev. and Mag. Zool., 1859, p. 125, pl. VI.

*Pseudelaps bimaculatus*, Jan., Icon. Gen., Livr. 43, 1873, pl. V., fig. 2.

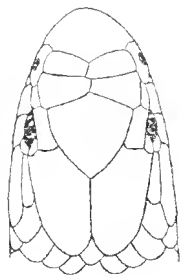
*Furina bimaculata*, Boulenger, Cat. Sn. Brit. Mus., III, 1896, p. 406 (see synonymy).

" " Werner, Fauna, Süd.-Austr., II., 1909, p. 262.

There are two specimens of this rare snake in the collection. The largest 317 mm. long and has 181 ventrals, 30/29 subcaudals, 2 anals, 1 + 1 temporals, the first very long. The smaller specimen which is 230 mm. long differs somewhat from Boulenger's descrip-

<sup>1</sup> Werner—Fauna Süd.-Austr., II, 1909, p. 258.

tion in having 217 ventrals, 20/19 subcaudals, and in being uniformly coloured on the body. The two characteristic black bands on



TEXT FIG. 7.

*Furina bimaculata*, D. and B.

Dorsal view of head enlarged.

the nape and head are present in both specimens, but the smaller one has a black blotch on the rostral. With these variations and those noted by Werner the scale formulae should now stand:—Sc. 15 rows, V. 181-217, S.c. 20/19 to 30/29. Anal 2. Labials  $\frac{5}{6}$ . Temporals 1 + 1-2.

The upper head shields of the larger specimen are figured.

## BATRACHIA.

### (FROGS AND TOADS).

#### KEY TO THE WESTERN AUSTRALIAN FROGS AND TOADS.

- A. Toes free or fringed only, <sup>1</sup> the fringe sometimes forming a very membrane at the base of the toes.
  - B. Inner metatarsal tubercle large, *shovel-shaped*.
    - C. Teeth in two transverse series *behind* the choanae.
      - D. A large parotoid-like gland on the calf of the leg. Brown above with dark brown spots or bands and a light dorsal stripe.
 

*Limnodynastes dorsalis*, Gray, var. *typica*.
      - DD. No parotoid-like gland on the calf of the leg. Back beautifully variegated with symmetrical greyish and yellowish marks. Rarely a dorsal band.
 

*Limnodynastes ornatus*, Gray.
    - CC. Teeth in two groups *between* the choanae.
      - E. Back granulated. Brown or purplish-black above, uniform or with lighter spots.
 

*Heleioporus albopunctatus*, Gray.

<sup>1</sup> In the case of *Limnodynastes ornatus* the toes may be fringed only, or as much as two-thirds webbed. This species is therefore placed in both divisions of the Key, A. and A.A.

BB. Inner metatarsal tubercle *moderate or small*; not or but little larger than the other.

F. Under surfaces *smooth*.

G. A large *white spot* on the hinder side of the thighs.

H. A large swollen parotoid gland on the shoulder. Two rather large sub-equal metatarsal tubercles. Dark spotted beneath.

*Uperoleia marmorata*, Gray.

GG. No large white spot on the hinder side of the thigh.

I. *Smooth above*. No parotoid gland. A broad dark brown band starts between the eyes and extends to the sacral region where it bifurcates. Beneath spotted with darker.

*Crinia leai*, Fletcher.

II. Upper surfaces with *prominent smooth warts*. An indistinct subcircular parotoid gland on the shoulder. Brown or olive above, lighter on the forehead and a few large patches on the back. Beneath with faint marks

*Pseudophryne guentheri*, Boulenger.

FF. Under surfaces coarsely *wrinkled, not granular*.

J. Tympanum hidden. Habit extremely stout. Limbs excessively short. Toes not longer than the fingers.

*Myobatrachus gouldii*, Gray.

FFF. Under surfaces *granular*.

K. Tympanum slightly distinct. Vomerine teeth present or absent. Belly *immaculate*. Hinder side of thighs *carmine*.

L. Back with warts or folds. Middle of back dark brown, A broad dorso-lateral yellowish band, sometimes divided by fine lines.

*Crinia georgiana*, Bibr., var. *stolata*, Cope.

LL. Back quite smooth. A dark lateral streak.

*Crinia georgiana*, Bibr., var. *affinis*. Günth.

KK. Tympanum quite hidden. Vomerine teeth none. Belly dark *spotted or marbled*. Hinder side of thighs *dark*, uniform or variegated.

M. Snout rounded, as long as the orbital diameter. Sub-articular tubercles rather small. A slight tarsal fold.

*Crinia signifera*, Girard.

AA. Toes distinctly *webbed* from one third to fully so.

N. Toes not more than half webbed. *A large oval, compressed*, inner metatarsal tubercle.

O. Teeth *between* the choanae.

P. Habit stout. Head rather pointed. Back with *large warts*. Toes short, one third to one half webbed. Brownish variegated above; sometimes a fine dorsal stripe.

*Phractops brevipalmatus*, Günther.

PP. Habit stout. Head *very large*; snout broadly rounded. Back finely *granulated* and with fine dorso-lateral fold. Toes short, broadly fringed, about half webbed. Greyish peppered with black above. Hinder side of thighs uniform. Head variegated. Young spotted above.

*Phractops australis*, Gray.

PPP. Habit rather *slender*. Head long and pointed. Back warty, with longitudinal folds. Toes *long* nearly *entirely* webbed. Uniform or marmorated brown above. A canthal streak. Hinder side of the thighs and groin with black and white spots.

*Phractops alboguttatus*, Günther.

OO. Teeth in two transverse series *behind* the choanae.

Q. Tympanum very indistinct. Head high; snout very short. Back beautifully variegated.

*Limnodynastes ornatus*, Gray.

NN. Toes webbed to or almost to the discs. Inner metatarsal tubercle *not shovel-shaped*, generally not different from the outer when present.

R. Fingers *at least one-third webbed*. Discs *very large*.

- S. *Uniform* green above (bluish in spirits). Vomerine teeth in two groups on a level with the *hinder edge* of the choanae.

*Hyla caerulea*, White.

- SS. *Variegated* brown above; hinder side of thighs black marbled. Vomerine teeth in two groups *between* the choanae.

*Hyla peronii*, Bibron.

- SSS. Finger discs two-thirds the tympanum; discs of toes *small*. Front and hinder side of thighs, groin and axilla, *excessively* blotched with black.

*Hyla peronii*, Bibr., var. *rothii*, de Vis.

- RR. Fingers *free or webbed at the base*. Discs generally small, sometimes not enlarged.

- T. Fingers *webbed at the base*. Discs distinctly enlarged, as large as the tympanum or only half so.

- U. Discs of fingers as large as the tympanum. Head broader than long; snout *rounded*. Hinder side of thighs and groin with large purplish black spots.

*Hyla ewingii*, D. and B., var. *calliscelis*, Ptrs.

- UU. Discs of fingers distinct, only half the tympanum. Head longer than broad; snout *prominent*. Hinder side of thighs dark, uniform or with white spots.

*Hyla adelaidensis*, Gray.

- TT. Fingers *quite free*. Discs of fingers never more than half the size of the tympanum, sometimes scarcely enlarged. Generally a small outer metatarsal tubercle.

- V. Habit *moderate*. The tibiotarsal articulation of the outstretched limb reaches the nostril or not so far.

- W. Hinder side of thighs bluish or greenish, *uniform*. A broad dorsal and a lateral stripe. Under surfaces *uniform* creamish-white.

*Hyla aurea*, Lesson, var. *typica*.

WW. Hinder side of thighs *black with white spots*.  
Belly and under surfaces of thighs with  
dense black and brown *reticulations*  
(absent in young).

*Hyla aurea*, Less., var. *cyclorhynchus*, Blng.

VV. Habit *very slender*. The tibiotarsal articulation of  
the outstretched limb reaches the tip of the snout  
or far beyond.

X. Back *smooth* or with very *faint smooth warts*.  
Hinder side of thighs with very accentuated  
black markings.

*Hyla latopalmata*, Günther.

XX. Back with *longitudinal folds* and dark with  
light brown stripes. Hinder side of thighs  
longitudinally striped with black or brown.  
Snout and toes excessively long, the tibio-  
tarsal articulation of the outstretched limb  
reaching far beyond the tip of the snout.

*Hyla nasuta*, Gray.

### LIMNODYNASTES ORNATUS, Gray.

- Limnodynastes ornatus*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 262.  
" " Spencer, Rept. "Horn" Sci. Exped. Centr. Austr., II.,  
1896, p. 156, pl. XII., figs 3 and 4 and pl. XV., figs.  
18-25.  
" " Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898),  
pp. 676 and 682.

**Locality.**—Napier Broome Bay, Northern coast of W.A. One  
specimen.

### LIMNODYNASTES DORSALIS, Gray, var. TYPICA, Fry.

- Limnodynastes dorsalis*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 261.  
" " Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898),  
p. 675.  
" " var. *typica*, Fry, Rec. Austr. Mus., X., 1913, p. 24, pl. II,  
fig. 2.

Ten specimens are in the collection. I have utilised these in  
an already published account of the variations of *L. dorsalis*.

## CRINIA GEORGIANA, Bibr., var. STOLATA, Cope.

(PLATE XXVIII, FIG. 1.)

*Crinia georgiana* var *stolata*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882,  
p. 264. - -

Vomerine teeth in two indistinct, convergent groups, behind the level of the choanae. Tongue rather large, elongate oval and entire. Tympanum slightly distinct. Fingers and toes with a slight fringe. Subarticular tubercles well developed; palmar and plantar surfaces with numerous distinct granules. Two distinct metatarsal tubercles. Tarsal fold very indistinct. Upper surfaces with longitudinal folds and warts. Under surfaces coarsely granular.

**Colour** (Spirits).—Back with a broad dark median area which is variegated with darker. A yellow dorso-lateral band, divided by numerous thread-like lines, starts behind the eye and bifurcating, runs to the groin. Sides of body and head variegated and striped. Legs barred and beautifully variegated with light and dark brown. Groin and hinder side of thigh bright carmine. Under surfaces with a few faint grey spots, most distinct on the throat.

Total length from snout to vent ... 24 mm.

Width of head ... 8.5 mm.

Length of head to level of tympana 8 mm.

Length of the outstretched hind limb 34 mm.

This is a very beautiful variety and is very distinct. The specimen figured on Plate XXVIII, fig. 1, agrees in all essentials with Bell's figure <sup>1</sup> of *Cystignathus georgianus*, but I regret that I am unable to refer to Cope's original description <sup>2</sup> of *Crinia stolata*.

**Locality**.—A single specimen from the Margaret River in the collection.

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## CRINIA LEAI, Fletcher.

(PLATE XXVIII, FIGS. 2 and 2a.)

*Crinia leai*, Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898), p. 677.

Vomerine teeth in two distinct, convergent groups behind the choanae, or they may be entirely wanting. Tongue rather large, elongate oval and entire. Tympanum quite hidden. Fingers

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<sup>1</sup> Bell—Zool. "Beagle" Rept., 1843, p. 33, pl. XVI., fig. 4.

<sup>2</sup> Cope—Journ. Acad. Philad. (2), VI., 1867, p. 201.

cylindrical, not fringed, first shorter than second. Toes with a distinct fringe or devoid of a fringe. Subarticular tubercles low and flat, rather indistinct. Palmar and plantar surfaces devoid of granules. A small inner metatarsal tubercle. No tarsal fold. Upper and lower surfaces smooth except for a granulated area on the under surface of the thighs.

**Colour** (Spirits).—Dark or light blackish-grey above, forehead lighter. A broad black, sometimes light edged band starts between the eyes and runs to the sacral region, bifurcating to a varying extent. This band may be represented by spots only. A dark streak on the canthus rostralis. Lips spotted. Legs and arms transversely barred with black, sometimes absent. A dark, light-edged streak or triangular spot on the hinder side of the thighs near the anus. Under surfaces with numerous blackish-grey spots, the shank, tarsus and metatarsus being much darker, sometimes blackish.

Total length from snout to vent ... 22 mm.

Width of head ... 8 mm.

Length of head ... 8 mm.

Length of outstretched hind limb ... 34 mm.

**Locality**.—A single specimen is in the collection from the Margaret River, which agrees well with Mr. Fletcher's description.

## PHRACTOPS AUSTRALIS, Gray.

*Chiroleptes australis*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 269.

" " Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898), pp. 678 and 682.

There is a single example in the collection which differs from eastern specimens in having a smoother back, slightly narrower head, and a very accentuated canthal and temporal streak.

**Locality**.—Napier Broome Bay.

## HELIOPORUS ALBOPUNCTATUS, Gray.

TEXT FIGS. 8b. AND 10.

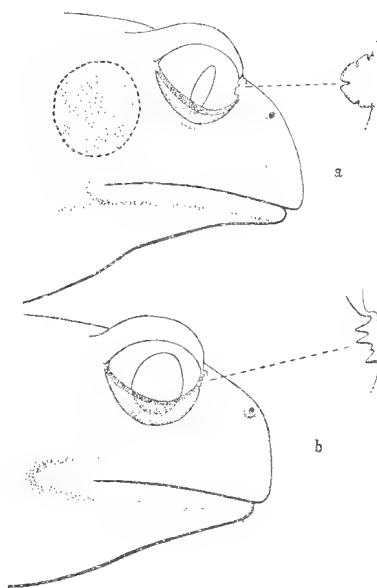
*Heleioporus albopunctatus*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 271.

" " Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898), p. 678.

I find a small but constant structure in this species which appears to have hitherto escaped notice. At the anterior corner of



the eye (see Text Fig. 8b) is a small fold of integument, beset with three or four conical papillae, which when the eye is closed, fits over the anterior junction of the upper and lower eye-lids. This structure is apparently of secondary importance during burrowing operations which have unfortunately never been observed in this species. However, in allied burrowing forms, and in particular *Philocryphus flavoguttatus* and *Limnodynastes dorsalis*, var. *dumerilii* burrowing has been carefully observed and there is no reason to believe that it differs to any extent in *H. albopunctatus*. The large eyes which under normal conditions protrude considerably, can be withdrawn well into the orbits and even to below the general surface of the head. This is done during the burrowing process by the two species mentioned above, just before the frog's head disappears beneath the surface of the earth, and it will be found if the mouth be opened and examined at this stage that its cavity is nearly filled by the downward bulge of the orbits. The upper eyelid has little power movement, but by the contraction of the eye into the orbit it is drawn considerably over the eye, while the thin semi-transparent lower lid is drawn up under its outer edge. When so closed, this serrated flap of skin



TEXT FIG. 8.

- a. *Philocryphus flavoguttatus*, Fletcher.  
Side view of head, enlarged.
- b. *Helioforus albopunctatus*, Gray  
Side view of head, enlarged.

which is a direct downward continuation of the upper eye-lid, would function as a valve to prevent the small particles of grit from entering the eye during the frog's passage through the earth. In *Philocryphus flavoguttatus* (Text-fig. 8a) an homologous structure occurs, but differs from that of *H. albopunctatus* (Text-fig. 8b) in being larger and semi-circular in outline, with several nicks on its free edge. It is also to be regarded as of an accessory nature as it is not a direct continuation of the upper eyelid, but quite separate from that structure. *Helioporus pictus* and *Limnodynastes dorsalis*, which are both burrowers, possess no such apparatus, but in the former, the anterior free edge of the upper eye-lid overlaps the lower to an unusual extent, and apparently serves the same purpose. In *Pomatops valvifera*, a New Guinea representative of the Family Engystomatidae. Dr. Barbour<sup>1</sup> records an interesting development of this nature. The upper eye-lid is in the form of a flap of skin which extends for some distance anterior and posterior to the eye, and which is sufficiently developed to allow of its laying down so that it covers the whole eye. By analogy Dr. Barbour regards this frog as a burrower.

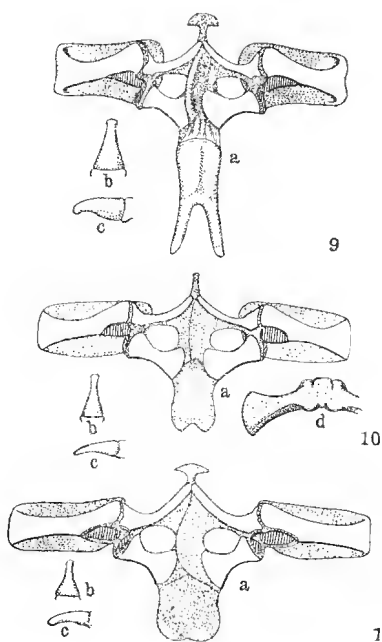
The two specimens in Mr. Woodward's collection are from the Margaret River. They are the hosts of a great number of the maggot larvae of some Dipterous insect, probably *Batrachomyia*.<sup>2</sup> Each of these maggots causes a gall-like swelling of considerable size and a frog so infested presents a remarkable sight.

Mr. Fletcher<sup>3</sup> has suggested that "if the generic definition of *Heleioporus* be amended in respect to the tympanum" his genus *Philocryphus* might be regarded as synonymous with it. He also notes the very different form of the sternum but apparently did not value it as a generic character. The widely different nature of the sterna of these two species (Text-Figs. 9a and 10a) seems to me to justify their generic separation, and with such a tangible external character as a distinct tympanum, as opposed to a hidden one in *Helioporus*, Mr. Fletcher's genus appears to be very well founded. The chief differences in the sternal apparatus lie in the sternal plate itself. In *Philocryphus* (Text Fig. 9a) it is a densely calcified plate with a slight median ventral ridge; it is produced backwards into two cylindrical, diverging, bony horns nearly as long as the sternal

<sup>1</sup> Barbour—Proc. Biol. Soc. Wash., XXIII, 1910, p. 89, pl. 1.

<sup>2</sup> Skuse—Proc. Linn. Soc., N.S.W. (2), IV, p. 172.

<sup>3</sup> Fletcher—Proc. Linn. Soc., N.S.W., XXII., 1897 (1898), p. 678.



TEXT FIGS. 9, 10 and 11.

Text fig. 9.—*Philocryphus flavoguttatus*, Fletcher.Text fig. 10.—*Heliophorus albopunctatus*, Gray.Text fig. 11.—*Heliophorus pictus*, Ptrs.

- a. Ventral view of sternal apparatus.
- b. Dorsal view of terminal phalanx of fourth toe.
- c. Lateral view of same.
- d. Dorsal view of sacral vertebra.

plate, and separated from one another at their tips by a distance equal to their length. In *Heliophorus albopunctatus* (Text Fig. 10a), the sternum is a weak, semi-ossified plate, slightly nicked posteriorly; the ossification is confined to two longitudinal tracts one each side of the median line. In *Philocryphus* the free edge of the left or ventral-most epicoracoid cartilage is slightly calcified and considerably thickened; it forms a prominent ridge for the attachment of the anterior section of the pectoralis major muscle. No such ridge is discernible on the epicoracoid of *H. albopunctatus*, nor do the two epicoracoids overlap to nearly the same extent as in *Philocryphus*. Another difference is apparent in the shape of the omosternum. In *H. albopunctatus*, it is a simple narrow band of cartilage, while in *Philocryphus* it is expanded anteriorly into a semi-circular plate. The omosternum, however, shows considerable variation in this (see Text Fig. 11a, *H. pictus*)

and other Cystignathoid genera, notably Limnodynastes, so that only specific importance can be attached to it. In *H. pictus*, it bears a much closer resemblance to that of Philocryphus than does *H. albopunctatus*. Philocryphus is a much larger and stouter form than its western ally, and has much more powerful arms. In correlation with this development we find the strongly calcified sternum with its ventral ridge, and the downturned thickened edge of the left epicoracoidal cartilage; the pectoral muscles which find attachment at these ridges are the largest I have observed in any Australian frog.

The sternal apparatus of *H. pictus* (Text fig. 11a) differs from that of *H. albopunctatus* in minor points only. The most important difference is the broader sternal plate which shows no sign of ossification. The omosternum is expanded anteriorly and is not unlike that of Philocryphus.

The two genera may be characterised as follows:—

### HELIOPORUS, Gray.

Pupil erect. Tongue subcircular, slightly nicked behind. Vomerine teeth between the choanae. Tympanum concealed. Toes sometimes as much as half-webbed. Outer metatarsals united. Omosternum cartilaginous; sternum a cartilaginous or semi-ossified plate, nicked behind. Sacral vertebra dilated. Terminal phalanges stout, simple.

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### PHILOCRYPHUS, Fletcher.

Pupil erect. Tongue subcircular, slightly nicked behind. Vomerine teeth between the choanae. Tympanum quite distinct. Toes with a thick basal web. Outer metatarsals united. Omosternum cartilaginous; sternum a strongly calcified plate with a slight median ventral ridge and two strong xyphisternal horns. Sacral vertebra dilated. Terminal phalanges moderate, simple.

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### MYOBATRACHUS GOULDII, Gray.

*Myobatrachus gouldii*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 329.  
,, ,, Fletcher, Proc. Linn. Soc. N.S.W., XXII, 1897 (1898),  
pp. 680 and 681.

I have examined four specimens of this species and find that they differ in several points from Dr. Boulenger's description. The

pupil is in every case horizontal, and the tympanum is hidden. The under surfaces are coarsely wrinkled, and although not granular, could hardly be described as smooth. An examination of further specimens will be necessary to decide whether this condition is natural.

**Localities.**—Two specimens are in the collection. In the Australian Museum are two specimens taken by Mr. H. Richards at the Harvey, eighty miles south of Perth.

### HYLA CAERULEA, White.

- Hyla caerulea*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 383.  
 " " Fischer, Zool. Gart., XXIV., 1883, pp. 21 and 55 (habits).  
 " " Fletcher, Proc. Linn. Soc. N.S.W., XXII, 1897 (1898), pp. 669 and 681-2.  
 " " Garman, Bull. Mus. Comp. Zool., XXXIX., 1901, p. 14 (note only).  
 " " Boulenger, Zool. Jahrb., Supplm., XV., Bd. I., 1912, p. 211.  
 " *irrorata*, de Vis, Proc. Roy. Soc. Q'land., I., p. 128.  
 " " Boulenger, Ann. Mag. Nat. Hist. (5). XVI., 1885, p. 387 (= *H. infrafrenata* ?)  
 " " Fry, Rec. Austr. Mus., IX, 1912, p. 100 (= *caerulea*).

**Locality.**—A single specimen is in the collection from Napier Broome Bay.

### HYLA RUBELLA, Gray.

- Hyla rubella*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 405.  
 " " Spencer, Rept. "Horn" Sci. Expdn., II., 1896, p. 170, pl. XV., figs. 26-28.  
 " " Fletcher, Proc. Linn. Soc. N.S.W., XXII., 1897 (1898), p. 669.

**Locality.**—A single specimen from Napier Broome Bay.

### HYLA ADELAIDENSIS, Gray.

- Hyla adelaidensis*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 408.  
 " " Fletcher, Proc. Linn. Soc., N.S.W., XXII., 1897 (1898), p. 681.

**Locality.**—Several specimens are in the collection from Harvey.

### HYLA LATOPALMATA, Günther.

- Hyla latopalmata*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 414, pl. XXVI., fig. 4.  
 " " Fletcher, Proc. Linn. Soc., N.S.W., XXII., 1897 (1898) pp. 681-2.  
 " " Fry, Rec. Austr. Mus., X., p. 20, pl. I and Fig. 12.

**Locality.**—Four specimens from Napier Broome Bay.

## HYLA NASUTA, Gray.

- Hyla nasuta*, Boulenger, Brit. Mus. Cat. Batr., 2nd ed., 1882, p. 415.  
" " Fletcher, Proc. Linn. Soc. N.S.W., XXII, 1897 (1898), p. 682.  
" " Kampen, Nova Guinea, V., 1909, p. 35.  
" *peninsulae*, de Vis, Proc. Roy. Soc. Q'land., I, 1884, p. 129.  
" " Boulenger, Zool. Rec., 1885, Rept., p. 24 (= *nasuta*.)  
? " *semoni*, Böttger, in Semon's Zool. Forsch., V., 1894, p. 112, pl. V, fig. 1.

**Locality.**—Three specimens from Napier Broome Bay. Collected by Mr. G. F. Hill. This species has not been previously recorded from Western Australia.

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# NOTES ON SOME WESTERN AUSTRALIAN FISHES.

— BY —

ALLAN R. McCULLOCH,  
ZOOLOGIST, AUSTRALIAN MUSEUM.

PLATES XXIX.XXXI., and FIG. 1.

The specimens on which the following notes are based are part of the collections referred to in my previous paper dealing with fishes from Western Australia.<sup>1</sup> Most of them are from South-western Australia, but a few from Port Hedland add a little to our knowledge of the fauna of the great North-western Coast, which is, at present, largely unknown.

Family RHINOBATIDAE.

## RHINOBATUS BANKSII, Müller and Henle.

*Rhinobatus banksii*, Waite, Mem. Austr. Mus., IV., pt. I., 1899, p. 38, pl. III.  
*Id.*, Zietz, Trans. Roy. Soc. S. Austr., XXXII, 1908, p. 292.

A young male, 580 mm. long, from Western Australia, does not differ from Port Jackson specimens of this species. *R. banksii* has been identified in South Australia by Zietz.

Family CLUPEIDAE.

## ETRUMEUS JACKSONIENSIS, Macleay.

PLATE XXIX.

*Etrumeus jacksoniensis*, Macleay, Proc. Linn. Soc. N S Wales, III., 1878, p. 36, pl. IV, fig. i, and *loc. cit.*, IV., 1879, p. 382. *Id.*, Ogilby, Ed. Fish. N.S.Wales, 1893, p. 186. *Id.*, Zietz, Trans. Roy. Soc. S. Austr., XXXII., 1908, p. 294.

D.21; A.11? P.16; V.9; C.17. Head 4.45 in the length to the hypural; height before the dorsal fin 5.54 in the same, and 1.24 in the head. Snout and eye subequal in length, the latter 3.06 in the

<sup>1</sup> McCulloch.—Rec. W. Austr. Mus., I., pt. 2, 1912, pp. 78-97, pls. IX-XIII.

head. Interorbital width equal to the depth of the caudal peduncle, 3.83 in the head. Mandible 2, maxillary 2.87, highest dorsal ray 1.53, and pectoral 1.53 in the head.

Body elongate, subcylindrical and slightly compressed. Head deeper than broad, pointed and flattened above. A thick, transparent membrane extends from the snout, over the eye to the preoperculum. Jaws subequal. Maxillary almost entirely exposed, only the upper edge slipping under the preorbital; it reaches back almost to below the anterior orbital border, and though broad, is scarcely expanded posteriorly. Hinder margin of preoperculum sloping very obliquely backwards and downwards, the angle sharply rounded. The opercular margin forms an obtuse angle posteriorly. No teeth are visible, even under a lense, but the jaws and bones of the palate are a little rough to the touch. Gill openings large, the membranes free from the isthmus.

Origin of dorsal almost midway between the tip of the snout and the vertical of the end of the anal. Ventrals inserted behind the tip of the adpressed dorsal and somewhat nearer the hypural than the pectorals; the first ray is more than one-third as long as its distance from the anal. Anal very small, its origin much nearer the hypural than the ventrals. Pectorals opening horizontally, the anterior rays as long as those of the dorsal; their hinder borders are a little emarginate.

Scales of moderate size, cycloid, and they appear to have fine longitudinal striations on their exposed surfaces. They are nearly all missing in my specimen, but there seem to have been eighteen on the back before the dorsal fin, and about fifty-six between the hinder margin of the head and the hypural. The bases of the dorsal and anal fins are enveloped in scaly sheaths, and the pectorals and ventrals each have a long flap composed of axillary scales.

The colour appears to have been dark blue on the back, sharply separated from the silvery sides and belly. Tips of the jaws blackish.

Described from a single specimen, 220 mm. long, from Albany. A few specimens of this species have been taken in Port Jackson, and it is recorded from South Australia by Zietz.



## Family ENGRAULIDAE.

## ENGRAULIS ANTIPODUM, Günther.

*Engraulis encrasicolus* var. *antipodum*, \*Günther, Brit. Mus. Cat. Fish., VII., 1868, p. 386.

Eight examples from Freshwater Bay, Swan River, do not differ from Tasmanian specimens in the Australian Museum.

## Family PLOTOSIDAE.

## CNIDOGLANIS MEGASTOMUS, Richardson.

*Plotosus megastomus*, Richardson, Zool. "Erebus and Terror," Fishes, 1845, p. 31, pl. XXI., fig. 1-3.

*Cnidoglanis megastoma*, Günther, Brit. Mus. Cat. Fish., V., 1864, p. 27. *Id.*, Klunzinger, Sitzb. Akad. Wiss. Wien., LXXX., i., 1879, p. 410.

*Cnidoglanis bostockii*, Castelnau, Proc. Zool. Soc. Vict., II., 1873, p. 140.

A young example, 177 mm. long, from the Swan River, does not differ from Port Jackson specimens of this species. It also agrees very well with Castelnau's description of *C. bostockii*, so that Klunzinger's suggestion of the identity of that species with *C. megastomus* is proved correct.

## Family MURAENIDAE.

## GYMNOTHORAX PRASINUS, Richardson.

*Gymnothorax prasinus*, Waite, Rec. Austr. Mus., V., pt. 3, 1904, p. 144.

Two specimens from Fremantle agree in every detail with others in the Australian Museum from near Sydney.

## Family ATHERINIDAE.

## ATHERINA PINGUIS (Lacépède) Ogilby.

*Atherina pinguis*, Ogilby, Mem. Qld. Mus., I., pt. I, 1912, p. 38, pl. XII., fig. 1.

Two examples are in the collection from Fremantle. Waite examined specimens from the same locality, and recorded them as *A. lacunosa*, Forster.<sup>1</sup>

<sup>1</sup> Waite, Rec. Austr. Mus., IV., 1902, p. 180.

Family POLYNEMIDAE.

Genus POLYDACTYLUS, Lacépède.

## POLYDACTYLUS (ELEUTHERONEMA)

### TETRADACTYLUS, Shaw.

- Polynemus tetradactylus*, Günther, Brit. Mus. Cat. Fish, II., 1860, p. 329. *Id.*, Day, Fish. India, 1878, p. 180. *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, VIII, 1883, p. 203. *Id.*, Kent, Gt. Barrier Reef, 1893, p. 287, pl. XLVI, fig. 2, and Nat. in Austr., 1897, p. 168-9.  
*Polynemus coecus*, Macleay, Proc. Linn. Soc. N.S. Wales, II., 1878, p. 354, pl. IX, fig. 1.

Having examined the type of *P. coecus* in the Macleay Museum, I have to support Klunzinger's opinion that that species is synonymous with *P. tetradactylus*.

A large specimen is preserved from Fremantle.

Family GADIDAE.

## PHYSICULUS BARBATUS, Günther.

- Physiculus barbatus*, Zietz, Trans. Roy. Soc. S. Austr., XXXIII., 1909, p. 266. *Id.*, McCulloch, Zool. Res. "Endeavour," pt. I, 1911, p. 38—synonymy.

Albany. One specimen, 345 mm. long.

Family PEMPHERIDAE.

Genus LEPTOBRAMA, Steindachner.

## LEPTOBRAMA MÜLLERI, Steindachner.

- Leptobrama mülleri*, Steindachner, Sitzb. Akad. Wiss. Wien, LXXVIII, i., 1878, p. 388, and Denks. Akad. Wiss. Wien, XLI, i., 1879, pl. III, fig. 1. *Id.*, Klunzinger, Sitzb. Akad. Wiss. Wien, LXXX, i., 1879, p. 381.  
*Neopempheris ramsayi*, Macleay, Proc. Linn. Soc. N.S. Wales, V., 1881, p. 517, pl. XIV.  
 ? *Neopempheris pectoralis*, Ramsay and Ogilby, Proc. Linn. Soc. N.S. Wales, (2), II., 1887, p. 563.

A comparison of the type of *Neopempheris ramsayi* with Steindachner's figure of *Leptobrama mülleri* leaves no doubt as to the identity of the two species.

Mr. Ogilby has examined several specimens from Moreton Bay and informs me that he considers *N. pectoralis*, may be synonymous with *N. ramsayi*. I have compared the two type specimens and find only a few differences between them which are probably not specific. Mr. Ogilby will give details in his paper in the memoirs of the Queensland Museum.

A fine specimen, 297 mm. long, from Port Hedland, is in the Western Australian Museum collection.

Family SERRANIDAE.

EPINEPHALUS MEGACHIR, Richardson.

*Epinephalus megachir*, Boulenger, Brit. Mus. Cat. Fish., (2 ed.), 1895, p. 219.

Port Hedland. One specimen, 230 mm. long.

PSAMMOPERCA WAIGIENSIS, Cuvier and Valenciennes.

*Psammoperca waigiensis*, Boulenger, Brit. Mus. Cat. Fish., (2 ed.), I, 1895, p. 365.

A small specimen, 210 mm. long, from Geraldton, differs from larger ones in the Australian Museum from Torres Strait in having the snout more pointed, and its upper profile more concave.

Family PSEUDOCROMIDIDAE.

GNATHYPOPS INORNATUS, Ramsay & Ogilby.

PLATE XXX.

*Opisthognathus inornatus*, Ramsay and Ogilby, Proc. Linn. Soc. N.S. Wales, (2), II., 1887, p. 561.

A very large specimen, 485 mm. long, from Port Hedland, differs from the type in having a much smaller eye, the head very much more tumid, and the pectorals more rounded. The scales are obsolete anteriorly and the whole head, body and fins are covered with soft, plicated skin; on the anterior portion of the ventrals and the margin of the spinous dorsal the skin is particularly thick and convoluted. All these differences are doubtless due to the age of the specimen.

I have figured one of the two type specimens, which are in bad condition; only the spots on the body are copied from the larger example.

The following is a key to the Australian species of *Gnathypops*, Gill, and *Merogymnus*, Ogilby, all of which are represented in the Australian Museum.

- a. Outer row of teeth considerably larger than the others.  
Scales extending forward to below origin of soft dorsal.  
*Gnathypops*.
- b. Body and fins light with numerous small dark brown spots - - - - - *maculatus*.<sup>1</sup>
- bb. Body and fins dark, sometimes with irregular scattered dark spots - - - - - *inornatus*
- bbb. Head with small, body with large incomplete brown rings, dorsal, anal and caudal with oblique bars, the former with a large black spot anteriorly.  
*darwinienensis*.<sup>2</sup>
- aa. Outer row of teeth scarcely larger than the others.  
Scales not extending forward beyond middle of pectorals.  
*Merogymnus*.
- c. Scales very small, covering the greater part of the sides and belly - - - - - *eximius*.<sup>3</sup>
- cc. Scales larger, confined to hinder half of body, belly naked - - - - - *jacksonienensis*.<sup>4</sup>

I have compared the types of *Batrachus punctulatus*, Ramsay<sup>5</sup> and *Opisthognathus maculatus*, Alleyne and Macleay<sup>1</sup> and find them to be the same species.

#### Family GERRIDAE

Genus PAREQUULA, Steindachner.

#### PAREQUULA MELBOURNENSIS, Castelnau.

*Gerris melbournensis*, Castelnau, Proc. Zool. Soc. Vict., I, 1872, pp. 158, 245, and *loc. cit.*, II, 1873, p. 37. *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, V., 1881, p. 380.

*Parequula bicornis*, Steindachner, Denks. Akad. Wiss. Wien, XLI, i, 1879, p. 8. *Id.*, Klunzinger, Sitzb., Akad. Wiss. Wien, LXXX., i, 1879, p. 380.

*Chthamaloptyx melbournensis*, Ogilby, Proc. Zool. Soc., 1887, p. 616, figure. *Id.*, McCulloch, Zool. Res. "Endeavour" I, pt. I., 1911, p. 63.

Having compared the description of *Parequula bicornis* with the specimens on which Ogilby based his genus *Chthamaloptyx*, I have no doubt that the two names refer to the one species. According to Steindachner the scales are ctenoid (ciliated) along the edge and

<sup>1</sup> Alleyne and Macleay, Proc. Linn. Soc. N.S. Wales, I, 1877, p. 280, pl. IX, fig. 3.

<sup>2</sup> Macleay, Proc. Linn. Soc. N.S. Wales, II, 1878, p. 355, pl. IX, fig. 3.

<sup>3</sup> Ogilby, Proc. Roy. Soc. Qld., XXI, 1908, p. 18.

<sup>4</sup> Macleay, Proc. Linn. Soc., N.S. Wales, V, 1881, p. 570.

<sup>5</sup> Ramsay, Proc. Linn. Soc. N.S. Wales, VIII, 1883, p. 177.

on the outer surface near the margin, while Ogilby described them as cycloid. This discrepancy is explained by the fact that they appear cycloid to the naked eye, the very minute teeth being only visible under a microscope; some scales, also, particularly in young specimens, are quite smooth.

Nine specimens, 142-185 mm. long, are in the collection from Albany.

Family CHEILODACTYLIDAE.

DACTYLOPHORA, de Vis.

*Dactylophora*, de Vis, Proc. Linn. Soc. N.S.Wales, VIII., July 1883, p. 284 (*D. semimaculata*, de Vis).

*Psilocranium*, Macleay, Proc. Linn. Soc. N.S.W., VIII, Feb., 1884, p. 439 (*P. coxii*, Macleay).

This genus is apparently distinguished from all others of the family Cheilodactylidae in having the cheeks naked. In its short and high anal fin, large scales, and general form, it appears to be related to *Chirodactylus*, Gill.<sup>1</sup>

De Vis has described the teeth as arranged in several rows in the upper jaw, and in one in the lower. Mr. Ogilby has, at my request, re-examined the type specimen in the Queensland Museum, and finds a band of villiform teeth in the upper jaw, which is much broader in front than laterally, and three series of small curved teeth in the lower jaw. In full-grown specimens the teeth become much more numerous.

DACTYLOPHORA NIGRICANS, Richardson.

*Cheilodactylus nigricans*, Richardson, Proc. Zool. Soc., 1850, p. 63, and Ann. Mag. Nat. Hist., (2), VII, 1851, p. 279.

*Chilodactylus nigricans*, Günther, Brit. Mus. Cat. Fish, II., 1860, p. 79 *Id.*, Gill, Proc. Acad. Nat. Sci. Philad., 1862, p. 118 *Id.*, Günther, Ann. Mag. Nat. Hist., (3) XX, 1867, p. 59. *Id.*, Canestrini, Arch. Zool. Anat. (2), I., 1869, p. 155. *Id.*, Castelnau, Proc. Zool. Soc. Vict., I., 1872, p. 75. *Id.*, Macleay, Proc. Linn. Soc. N.S.Wales, V., 1881, p. 423. *Id.*, Johnston, Proc. Roy. Soc. Tasm., 1890 (1891), p. 31. *Id.*, Waite, Rec. Austr. Mus., VI, 1905, p. 63.

*Chilodactylus nebulosus*, Klunzinger, Arch. Naturg., XXXVIII, i., 1872, p. 26, and Sitzb. Akad. Wiss. Wien., LXXX, i., 1897, p. 364. *Id.*, Steindachner, Sitzb. Akad. Wiss. Wien., LXXXVIII, i., 1884, p. 1078, pl. II., fig. 1. *Id.*, Macleay, Proc. Linn. Soc. N.S.Wales, IX, 1884, p. 17.

*Dactylophora semimaculata*, de Vis, Proc. Linn. Soc. N.S.Wales, VIII 1883, p. 284. *Id.*, Macleay, Proc. Linn. Soc. N.S.Wales, VIII., 1884, p. 441.

*Psilocranium coxii*, Macleay, *loc. cit.*, p. 440, pl. XXII.

*Psilocranium nigricans*, Macleay, *loc. cit.*, p. 441.

<sup>1</sup> Gill, Proc. Acad. Nat. Sci. Philad., 1862, p. 119.

D. XV-XVI. 24-26; A.III. 9-10; P. 9 + 5-6; V.I.5; C.14-15; 1. lat. 48-51. Body moderately elongate, deeper in the young than in the adult, 3.24-4.10 in the length to the hypural. Head 3.3-4.10 in the same. Eye 4.38-6.23 in the head, and 1.61-2.23 in the snout. Snout 2.71-3, greatest breadth 2.11-1.77, caudal peduncle 3.56-2.84, longest pectoral ray 1.05-1.1, sixth dorsal spine 2.45-2.59 in the head. Eye 1.07-1.47 in the interorbital width.

Body covered with large cycloid scales, which become extremely small on the chest, and form a sheath at the bases of the dorsal and anal fins. Postorbital portion of head and opercles covered with small scales; remainder of the head naked. Fleshy eye-opening almost equal to the interorbital width in young specimens, much narrower in adults. Nostrils close together, in the hinder half of the snout; the anterior has a short skinny lobe. Lips very thick, maxillary reaching to below the anterior or posterior nostril. A band of small cardiform teeth in each jaw which is broad in front, but becomes very narrow on the sides; vomer and palatines toothless.

Spinous dorsal a little shorter than the soft, and its margin is a little arched; the sixth spine is usually the longest, the others decrease regularly in length. Anterior dorsal rays equal to or higher than the longest spine; they become regularly shorter, and the margin of the fin is straight. Third anal spine longer, but much weaker than the second; anterior rays much higher than those of the dorsals, the posterior ones very short, so that the margin is a little excavated. Pectoral, with five or six simple rays, the fifth from the bottom the longest, reaching backwards to above the vent in young specimens and not so far as the ends of the ventrals in adults. Caudal forked.

Lateral line almost straight from the operculum to the upper portion of the caudal peduncle; it is formed of very small scales intercalated between the larger ones of the body, each of which bears a simple or bifurcate tube.

The colour markings are very distinct in the young, less so in adults. They consist of six broad brown bands, with darker edges, which descend from the back and run obliquely forward on the sides; a seventh less distinct one is present on the caudal peduncle. In addition, irregular rows of large dark spots are present on the lower parts of the sides. Two brown bands extend backwards

from the eyes, and one below it; the spaces between them are silvery. All the fins are dusky with narrow white edges; the soft dorsal may bear several rows of rather large brown spots, while several still larger ones are present on the caudal.

I have examined fifteen specimens, including a well graduated series, varying in length from 163-575 mm. from the tip of the snout to the end of the middle caudal rays. Of these, four are from South Australia. Seven, including the type of *Psilocranium coxii* are either from the neighbourhood of Sydney, or purchased in the Sydney markets, and one is from the Melbourne market. The three others are said to have come from the Clarence River, New South Wales, but I do not consider the evidence of their capture so far north as satisfactory.

Macleay compared his type of *Psilocranium coxii* with the four South Australian specimens mentioned above which he identified as *Chilodactylus nigricans* and *Dactylophora semimaculata*.<sup>1</sup> He noted its generic identity with Richardson's species, but did not recognise that they were all merely growth stages of the one species. I forwarded one of the smallest of these to Mr. Ogilby for comparison with the type of De Vis' *Dactylophora*, and he informs me that it cannot be separated from that species. He also agrees that it is the young of *C. nigricans*.

Klunzinger has also described this young stage as *C. nebulosa*, and Steindachner has given a beautiful figure of it under that name. This may be compared with the very rough figure of *Psilocranium* to show the difference between the young fish and the adult.

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Family KYPHOSIDÆ.

KYPHOSUS SYDNEYANUS, Günther.

*Pimclepterus sydneyanus*, Ogilby, Ed. Fish. N.S. Wales, 1893, p. 40, pl. XVI.  
*Kyphosus sydneyanus*, Zietz, Trans. Roy. Soc. S. Austr., XXXIII, 1909, p. 267.

A single specimen, 235 mm. long, from Houtman Abrolhos, is similar to others from Port Jackson. Zietz has recorded the species from St. Vincent Gulf.

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<sup>1</sup> See Macleay, Proc. Linn. Soc. N.S. Wales, VIII., 1883, p. 441.

## TEPHRAEOPS TEPHRAEOPS, Richardson.

*Crenidens tephraeops*, Richardson, Zool. "Erebus" and "Terror," Fishes, 1847, p. 69, pl. LXI, figs. 1-2.

*Tephraeops richardsonii*, Günther, Brit. Mus. Cat. Fish., I., 1859, p. 432. *Id.*, Klunzinger, Sitzb. Akad. Wiss. Wien., LXXX, i., 1879, p. 356. *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, V., 1881, p. 410.

*Tephraeops tephraeops*, Waite, Rec. Austr. Mus., VI, 1905, p. 63

I count about 84 pores along the lateral line and 116 directly above it. Some notes on the teeth are given under *Melambaphes*.

Fremantle. One specimen, 290 mm. long.

## MELAMBAPHES, Günther.

*Melambaphes*, Günther, Ann. Mag. Nat. Hist., (3), XI, 1863, p. 115 (*M. nigroris*, Günther=*Girella zebra* Rich; not *Glyphisodon nigroris*, Cuv. and Val.)

*Girellichthys*, Klunzinger, Arch. Naturg., XXXVIII, i., 1872, p. 22 (*G. zebra*, Rich.)

*Neotephroceps*, Castelnau, Proc. Zool. Soc. Vict., I, July, 1872, pp. 68, 248 (*N. zebra*, Richardson).

This genus differs from *Tephraeops* only in having the whole operculum scaly, the body scales somewhat larger, and the anal fin with an even margin, the anterior rays not being produced beyond the general line of the fin.

The teeth of the two are similar. Richardson described the vomer and palatines as toothless in *Tephraeops*, while Klunzinger found a group of small teeth on the vomer in *Girellichthys*. In my specimens of both genera, there are two or three minute, isolated, fixed teeth on the vomer, and a similar patch on the hinder end of each palatine bone; besides these, there are numerous microscopic setiform, dermal teeth, which are quite soft, surrounding the stronger fixed ones. All these teeth are very difficult to find, and might be easily overlooked.

## MELAMBAPHES ZEBRA, Richardson.

*Crenidens zebra*, Richardson, Zool., "Erebus" and "Terror," Fishes, 1847, p. 70. *Tephraeops zebra*, Günther, Brit. Mus. Cat. Fish., I, 1859, p. 432. *Id.*, Ogilby, Cat. Fish. N.S. Wales, 1886, p. 18.

*Melambaphes nigroris*, Günther, Ann. Mag. Nat. Hist., (3) XI, 1863, p. 115. (Not *Glyphisodon nigroris*, Cuvier and Valenciennes.)

*Girella zebra*, Steindachner, Sitzb. Akad. Wiss. Wien., LIII, 1866, p. 430, pl. VI, fig. 2.

*Neotephroceps zebra*, Castelnau, Proc. Zool. Soc. Vict., I, 1872, p. 69. *Id.* Macleay, Proc. Linn. Soc. N.S. Wales, V., 1881, p. 410.

*Girellichthys zebra*, Klunzinger, Arch. Naturg., XXXVIII, i., 1872, p. 22, and Sitzb. Akad. Wiss. Wien., LXXX, i., 1879, p. 356.



Mr. C. Tate Regan has, at my request, very kindly compared Günther's type specimen of *Melambaphes nigroris* with Steindachner's figure of *Girella zebra*, and writes to say that he has no doubt they represent the same species. Castelnau (*loc. cit.* p. 68) has given reasons for supposing that Günther's determination of the Victorian fish as *Glyphisodon nigroris*, Cuvier and Valenciennes, is incorrect. I fully agree with this conclusion, particularly as the latter species is said to generally resemble *G. rakhi* and *G. bengalensis*, which are very different in appearance to *Melambaphes*.

I have examined four specimens from Albany, 180-290 mm. long. Of these one has thirteen dorsal spines, two have fourteen, and one has fifteen. There are 64-70 pores along the lateral line, and 90-100 scales immediately above it. A skin received from Count Castelnau as *Neotephrocoptes zebra*, is also in the Australian Museum.

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Family CHAETODONTIDAE.

HOLACANTHUS (CHAEOTODONTOPLUS)

PERSONIFER, sp. nov.

PLATE XXXI.

D.XIII.19; A.III.19; V.I.5; P.19; C.15. Body more elongate than is usual in the genus, the depth before the ventrals 2.3 in the length to the hypural. Head 4.7 in the same.<sup>1</sup> Eye  $3\frac{3}{4}$  in the head, as long as the snout without the upper lip. Interorbital space convex, about half as wide again as the eye. Suborbital bone a little wider than the eye. Maxillary vertical, lower jaw the longer. Posterior preopercular margin finely dentate, lower entire; the spine is very large, longer than the width of the interorbital space. Teeth cardiform, tricuspid, the median cusp much larger than the others; they are arranged in about five rows in each jaw of which the outer ones are the longest.

Entire head, body and fins, with the exception of the ventral rays, covered with minute, strongly ctenoid scales which are very irregularly arranged. Lateral line distinct anteriorly, scarcely

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<sup>1</sup> The anterior portion of this specimen having been partially cleaned out and refilled with straw, the head is somewhat distorted, and these measurements may not be quite accurate.

traceable posteriorly; it originates above the operculum and is curved upwards towards the back, with which it appears to run nearly parallel to the end of the dorsal fin.

Dorsal commencing above the end of the operculum, the first spine rather short, the next two increasing rapidly in length, the others becoming gradually longer to the last. The margin of the fin is almost straight, the soft portion broadly rounded behind. Anal of similar form to the dorsal. Upper pectoral rays longest; the margin of the fin rounded. First ventral ray a little produced, and somewhat longer than the pectoral fin. Caudal slightly emarginate.

**Colour.**—Head grey, with large yellow spots. The anterior portion of the body and chest is bright yellow shading into white, this colour forming a sharp line with the deep black of the rest of the body which forms a backward curve from the first dorsal spine to the ventral fin. The black colour projects forward behind the pectorals on to the coracoid bone, and the basal half of the pectoral fin is also of this colour. Ventrals yellow with white tips. Dorsal and anal black like the body, as is the greater part of the caudal which bears a lunate, yellow, submarginal band with a narrow blackish border.

Described from a single example, 290 mm. long, from Shark Bay.

I am indebted to Mr. W. B. Alexander for notes on the life-colours of this specimen.

The colour pattern distinguishes this species from all others of the genus known to me, though I have been unable to compare it with *H. zebra*, *H. reginae*, and *H. caudibicolor* of Lienard.<sup>1</sup> It appears to be nearest allied to *H. conspicillatus*, Waite.<sup>2</sup>

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## HOLACANTHUS DUBOULAYI, Günther.

*Holacanthus duboulayi*, McCulloch, Rec. Austr. Mus. IX., pt. 3, 1913, p. 360, pl. XIV.

Port Hedland. Two specimens, 130-140 mm. long.

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<sup>1</sup> Lienard in Sauvage, Hist. Madagascar, XVI, 1891, pls. XXIX., XXXII., and XXXIV.

<sup>2</sup> Waite, Rec. Austr. Mus., III., 1900, p. 203, pl. XXXV.

## Family CARANGIDAE.

TRACHINOTUS RUSSELLII, Cuvier  
and Valenciennes?

*Trachinotus russellii*, Day, Fish. India, 1878, p. 233, pl. LI, b, fig. 3.

*Trachinotus russellii*, Stead, Ed. Fish N.S. Wales, 1908, p. 29, pl. LXII.

D.VII. 24 ; A.II.I.20. Head 3.53, depth 2.24 in the length to the hypural. Eye a little shorter than the snout, 4.3 in the head. Maxillary reaching to below the anterior portion of the pupil. Pectoral 1.3, ventral 2 in the head and reaching to the vent. Dorsal lobe a little shorter than the base of the soft portion of the fin ; anal lobe longer, longer than the base of the fin. Caudal lobes, measured from the hypural, almost equal to the height of the body; 2.26 in the length. An indefinite dark spot above the origin of the lateral line followed by four others placed just above the line, the last very indistinct. Dorsal and anal lobes dark as are the outer margins of the caudal.

One specimen, 265 mm. long, from Bernier Island.

An examination of the specimens of *T. russellii* available to me indicates considerable variation in this species and particularly in the depth of the body, length of the fin-lobes, etc., but the West Australian example has a larger head and more obtuse snout than others from Port Jackson and Lord Howe Island.

Ogilby has suggested<sup>1</sup> that the records of *T. russellii* and *T. baillonii*, Lacépède, from Australia require verification. It is of interest to note, therefore, that I have collected the latter at Murray Island in the Torres Strait, while I cannot separate Port Jackson and Lord Howe Island examples from *T. russellii*.

## Family BLENNIIDAE.

## BLENNIUS TASMANIANUS, Richardson.

*Blennius tasmanianus*, Waite, Rec. Austr. Mus., VI., 1906, p. 205, pl. XXXVI., fig. 5. *Id.*, Hall, Proc. Roy. Soc. Tasm., 1902, p. 1.

Seven examples of this extraordinarily variable species from Fremantle, do not differ from some Tasmanian specimens in the Australian Museum. Length 47-77 mm.

<sup>1</sup> Ogilby, Proc. Roy. Soc. Qld., XXI, 1908, p. 15.

## Family BATRACHOIDIDAE.

## Genus PSEUDOBATRACHUS, Castelnau ?

- ? *Pseudobatrachus*, Castelnau, Res. Fish. Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p. 24 (*P. striatus*, sp. nov.)  
*Batrachomoeus*, Ogilby, Ann. Qld. Mus., No. 9, 1908, p. 46 (*B. minor*, sp. nov. — *Batrachus dubius*, Shaw).

I follow Ogilby in regarding *Pseudobatrachus* and *Batrachomoeus*, as probably identical, but prefer to use the earlier name until they can be shown to be distinct.

## PSEUDOBATRACHUS DUBIUS, Shaw.

- Lophius dubius*, Shaw in White, Voy. N.S. Wales, 1790, p. 265 and plate.  
*Batrachus dubius*, Richardson, Voy. "Erebus" and "Terror" Fishes, 1844, p. 16, pl. X, figs. 1-2. *Id.*, Günther, Brit. Mus. Cat. Fish., III, 1861, p. 169, and Ann. Mag. Nat. Hist. (3), XX, 1867, p. 61. *Id.*, Castelnau, Proc. Linn. Soc. N.S. Wales, III, 1879, p. 353. *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, V, 1881, p. 572. *Id.*, Ogilby, Cat. Fish. N.S. Wales, 1886, p. 31.  
*Batrachoides dubius*, Waite, Mem. N.S. Wales Nat. Club, 1904, p. 54.  
*Thalassophryne coeca*, de Vis, Proc. Linn. Soc. N.S. Wales, IX, 1884, p. 547.  
*Batrachomoeus coecus*, Ogilby, Ann. Qld. Mus., No. 9, 1908, p. 49.  
*Batrachomoeus minor*, Ogilby, Ann. Qld. Mus., No. 9, p. 47.  
? *Batrachus trispinosus*, Kner, Reise "Novara," Zool., I., 1865, p. 189 (not of Günther).  
[? Not *Batrachus dubius*, Alleyne and Macleay, Proc. Linn. Soc. N.S. Wales, I, 1877, p. 335. *Id.*, Macleay, *loc. cit.*, VIII, 1883, p. 267.  
*Opsanus dubius*, Jordan and Seale, Bull. U.S. Fish. Bur., XXV, 1906, p. 416 after Macleay.  
*Pseudobatrachus striatus*, Castelnau, Res. Fish. Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p. 24.  
*Batrachus striatus*, Macleay, Proc. Linn. Soc. N.S. Wales, V., 1881, p. 574.]

The first notice of this fish consists of a few lines of descriptive matter, accompanied by a very defective figure. No definite locality is given for it, though judging from White's narrative, it was almost certainly collected in, or very near, Port Jackson. Only one species of the Batrachoididae occurs near Sydney, where it is not uncommon, and is doubtless identical with that figured by Shaw. Ogilby<sup>1</sup> has placed *B. dubius* in the synonymy of *Coryzichthys diemensis*, Le Sueur, but I see no reason to accept this especially as that species is not so far known from New South Wales.

Ogilby described specimens from Moreton Bay as *Batrachomoeus minor*, and while recognising their probable identity with the

<sup>1</sup> Ogilby, Ann. Qld. Mus., No. 9, 1908, p. 51.

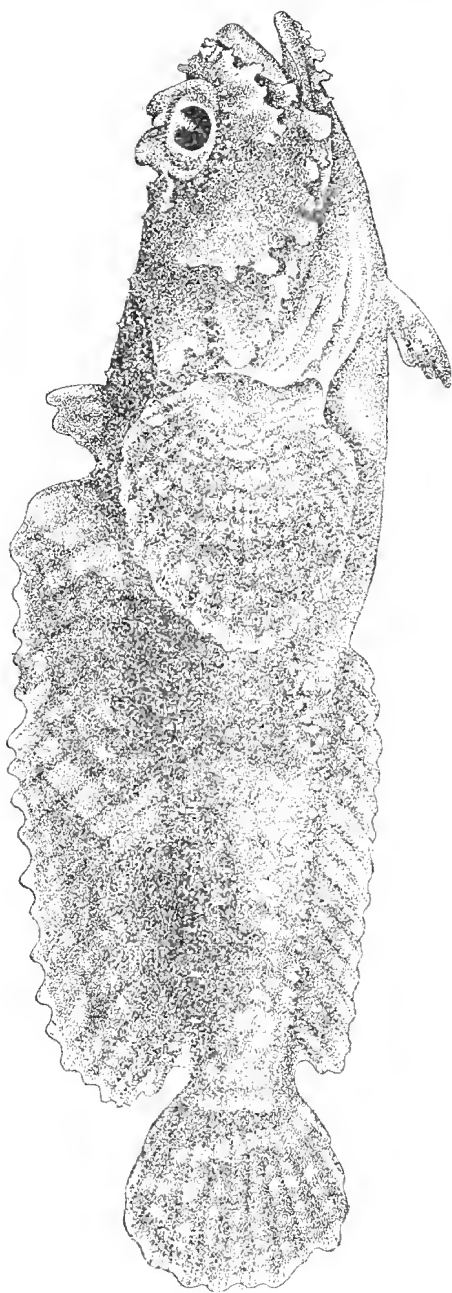


FIGURE I.

*Pseudobatrachus dubius*, Shaw.

*Batrachus dubius* of most authors, though not of Shaw, he considered they differed in having a narrower interorbital space and shorter tentacles. I have compared two specimens received from him as his species, with others from Port Jackson and find them identical in every way. In a well graduated series of fourteen specimens, 45-320 mm. long, the interorbital width increases regularly with size, being much narrower than the eye in young specimens, and considerably wider than it in adults. The tentacles are always short and thick. In Richardson's figure, by which Ogilby has probably been guided, they are shown much too long and straggling.

There is a young specimen 102 mm. long, in the Australian Museum from Garden Island, Port Jackson, caught and beautifully preserved by my friend Staff Paymaster P. B. Stevens, R.N. It shows the form and arrangement of the tentacles and colour particularly well, though the former are proportionately larger than in older examples, and is figured above.

Mr. Ogilby has recently informed me he is now sure that *Thalassophryne coeca*, de Vis, is merely the adult of the estuarine form which he described as *Batrachomoeus minor*. He also agrees that both are synonymous with *P. dubius*, de Vis' specimen being a large example from deep water.

A single large specimen is in the Western Australian Museum from Fremantle. Macleay recorded specimens from Torres Strait and New Guinea, but the records need verification, since his specimens are no longer in the Macleay Museum and his identifications of all specimens of this family were very faulty.

#### Family ANTENNARIIDAE.

### ANTENNARIUS UROPTHALMUS, Bleeker.

*Chironectes caudimaculatus*, Richardson, Zool. "Erebus" and "Terror," Fishes, 1848, p. 125, pl. LX., figs. 8-9 (perhaps not *C. caudimaculatus*, Rüppell)

*Antennarius caudimaculatus*, Bleeker, Atl. Ichth., V., 1865, p. 15, pl. CXCVII. fig. 6.

*Antennarius urophthalmus* Bleeker, Nat. Tyd. Ned. Ind., II., 1851, p. 488. *Id.*, Günther, Brit. Mus. Cat. Fish., III., 1861, p. 192. *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, II., 1878, p. 356. *Id.*, Klunzinger, Sitzb. Akad. Wiss. Wien., LXXX, i., 1879, p. 388.

A specimen from Broome, 120 mm. long, agrees very well with Richardson's and Bleeker's figures of this species. It has not previously been recorded from Western Australia.

## PTEROPHRYNE HISTRIO, Linnaeus.

*Antennarius marmoratus*, Günther, Journ. Mus. Godeffroy, V., 1876, p. 162, pl. C. fig. a.

One specimen from Western Australia without definite locality.  
Length 67 mm.

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## Family TETRAODONTIDAE

## SPHEROIDES PLEUROGRAMMA, Regan.

*Tetrodon hypselogenion*, Steindachner, Sitzb. Akad. Wiss. Wien, LIII, 1866, p. 478, *Id.*, Günther, Brit. Mus. Cat. Fish., VIII, 1870, p. 277 (part). *Id.*, Macleay, Proc. Linn. Soc. N.S. Wales, VI, 1881, p. 337. *Id.*, Waite, Rec. Austr. Mus., V., 1903, p. 38 (not *T. hypselogenion*, Bleeker).

*Tetrodon pleurogramma*, Regan, Proc. Zool. Soc., 1902 (1903), II., p. 300, pl. XXIV fig. 2.

A large example, 165 mm. long, from Fremantle, differs from smaller ones from Eastern Australia only in having the white spots on the back larger and more distinct. The Australian Museum collection includes specimens from near Sydney, New South Wales; Moreton Bay, Queensland; and Lord Howe Island.

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## Family BALISTIDAE.

## ABALISTES STELLARIS, Bloch and Schneider.

## var. PHALERATUS, Richardson.

*Balistes phaleratus*, Richardson, Stokes' Discov. in Austr., I., 1846, p. 484, pl. V., fig. 4.

*Balistes stellatus*, Günther, Brit. Mus. Cat. Fish., VIII., 1870, p. 212.

Two young specimens from Port Hedland, 110-115 mm. long, differ from Indian specimens of the typical *stellaris* in some details of colour marking. Instead of the small light spots on the body, the sides bear numerous large angular grey spots, and the blackish marking on the upper parts is formed of similar darker spots placed closer together. The first dorsal is largely black, and the second dorsal, anal, and caudal are marked with large greyish spots and bands, the last named fin also having a blackish margin. This form is evidently a variety of *A. stellaris*, and was described and figured from Western Australia by Richardson as *B. phaleratus*.

REVISION OF THE  
FRESHWATER CRAYFISHES  
OF SOUTH-WESTERN AUSTRALIA.

BY

ALLAN R. McCULLOCH,  
ZOOLOGIST, AUSTRALIAN MUSEUM.

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PLATES XXXII TO XXXV.

Most of the material on which the following notes are based, was received in January 1912 from Mr. Bernard H. Woodward, Director of the Western Australian Museum. At my request, he very kindly collected together a large series of specimens of all sizes from various scattered localities. These prove to belong to three species of the genus *Cheraps*, and may be reasonably supposed to be representative of the fresh water crayfishes of South-western Australia. I am indebted, also, to Mr. W. B. Alexander for information on other specimens, since received by the Western Australian Museum. There are also a few examples in the Australian Museum which were collected near Perth and at Albany by Mr. A. Abjornssen, Inspector of Fisheries, Western Australia.

While engaged on the preparation of these notes I learnt that Mr. Geoffrey Smith was to read a paper before the Zoological Society of London on the crayfishes of Australia, and I preferred to avoid confusion by waiting until it had been published.<sup>1</sup> The greater part of the material available to him was collected in Tasmania and Victoria, though he had a few specimens from South-western Australia. Those I have examined belong to the same species as identified by him, but having a large and apparently representative series of each, I have been able to describe and figure some noticeable variations in their specific characters.

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<sup>1</sup> Smith, Proc. Zool. Soc., 1912, pt. I., pp. 144-171, pls. XIV-XXVII.



## CHERAPS, Erichson.

*Cheraps*, Erichson, Arch. fur Naturg., XII, i., 1846, p. 101. *Id.*, Von Martens, Monastb. Ak. Wiss. Berlin, 1868 (1869), p. 616.

*Chaeraps*, Smith, Proc. Zool. Soc., 1912, p. 165.

(Not *Cheraps*, Huxley, Proc. Zool. Soc., 1878 (1879), p. 768.)

The genus *Cheraps* was first defined by Erichson as a sub-genus of *Astacus*, Milne Edwards, for his *C. preissii*, but his definition does not include some of the most important characters by which the several genera of the family Parastacidae are distinguished.

Huxley, in 1868, raised it to the rank of a genus, and described the branchial structures in detail, but he only had a specimen from the Yarra River, Victoria, which he could not, with certainty, identify as a true *Cheraps*. Taking into consideration Smith's recent investigations on the Crayfishes of Australia, it is almost certain that Huxley's specimen was *Astacus bicarinatus*, Gray, which Smith made the type of his *Parachaeraps*. Therefore, *Cheraps* of Huxley, but not of Erichson, is identical with *Parachaeraps*.

Smith has again defined *Cheraps*, his definition being based on *C. quinquecarinatus*, Gray, *C. tenuimanus*, Smith, *C. quadricarinatus*, Von Martens, and *C. intermedius*, Smith, but unless these can be shown to be generically identical with the lost *C. preissii*, their claim to inclusion in *Cheraps* cannot be proved. For reasons given below, however I regard *C. intermedius* as synonymous with *C. preissii*; if this conclusion be accepted, it follows that Smith's definition correctly applies to *Cheraps*, Erichson.

## CHERAPS PREISSII, Erichson.

*Astacus (Cheraps) preissii*, Erichson, Arch. fur Naturg., XII, i., 1846, p. 101. *Id.*, Von Martens, Monatsbr. Ak. Wiss. Berlin, 1868 (1869), p. 617.

*Astacopsis preissii*, Haswell, Cat. Austr. Crust., 1882, p. 177.

*Chaeraps intermedius*, Smith, Proc. Zool. Soc., 1912, p. 168, pl. XXIV., fig. 2, and pl. XXVII., fig. 34.

*C. preissii* was very imperfectly described from a specimen taken in South-Western Australia and has not again been recognised.<sup>1</sup> This unique specimen is apparently lost since Dr. Von

<sup>1</sup> I consider the specimens from Victoria which Ortmann (Zool. Jahrb. VI., 1891, p. 8, pl. I., fig. 1.) identified as *C. preissii* to be almost certainly *Parachaeraps bicarinatus*, since it is improbable that a species occurring in the fresh waters of South-western Australia would also be found in Victorian rivers. Some notes on the distribution of *P. bicarinatus*, are given under the heading of that species.

Martens was unable to find it in the Berlin Museum in 1868, and Professor A. Brauer, Director of that Institution, has very kindly informed me that it is not there now, and that he does not know where it is.

For the purpose of this paper, I have examined over one hundred crayfish from several widely separated localities in South-western Australia. Most of these were received from Mr. Woodward who made special efforts to secure good series of as many different species as possible. They represent only three species—*C. quinquecarinatus*, *C. tenuimanus*, and *C. intermedius* and hence I suppose that no other occurs in that part of the Continent. Therefore, the lost *C. preissii* is identical with one of these, and for reasons given below, I believe that one to be *C. intermedius*.

According to Erichson the margins of the rostrum are entire while he does not note the presence of any keels on the carapace. In *C. tenuimanus* the rostrum is armed with several strong lateral teeth, and the carapace bears three keels in addition to the two extending backwards from the rostrum. *C. quinquecarinatus* also has five keels. *C. intermedius*, on the other hand, has only two which are more obtuse and less elevated than those of the other species, while the teeth of the rostrum are sometimes so small as to be easily overlooked; in addition to these facts, such other characters as Erichson has given, agree very well with my specimens of *C. intermedius*. Erichson's specimen was only three inches five lines long, and the chelae measured one inch in length and five lines in breadth. These proportions agree much better with Smith's *C. intermedius* than with another which I propose to separate as var. *angustus*, in which the chelae are much narrower, particularly in young specimens.

The following are the principal characters of the species as exhibited by eighteen specimens 95-161 mm. long from the tip of the rostrum to the end of the telson.

Carapace finely pitted above, minutely tubercular on the lower parts of the sides, the tubercles a little larger anteriorly; a series of slightly enlarged tubercles on the sides behind the cervical groove. Two obtuse keels, each terminating anteriorly in a very blunt spine or tubercle. Rostrum almost horizontal or obliquely deflexed, not reaching the end of the antennal scales; it is flat above and the margins are defined by very narrow, scarcely raised keels.

It ends in a spine and there are two, inconspicuous, lateral serrations on each side near the tip. Abdomen with pits, but otherwise smooth.

Chelipeds massive, the hand either half, or usually more than half as broad as long. It is smooth and rounded above with minute, rather scattered pits which become larger and more crowded on the outer surface. Inner margin raised, with seven to nine serrations which form rounded tubercles in large specimens; a tomentose patch inside this margin. Fingers either meeting along their whole length or more or less widely gaping. Mobile finger with a rounded tubercle about the middle of its length, which may be either extremely small, or large and followed by several smaller ones. Immobile fingers with a row of larger or smaller tubercles along the basal half. Wrist with a large blunt internal spine and sometimes a second smaller one at its base.

The colours are faded, but the chelae appear to have been purplish with many lighter spots.

Of the eighteen specimens, eleven are from Kojonup; six were collected in a billabong at Harvey, Harvey River; and one from Guildford, near Perth. Mr. Alexander has also seen it from streams outside the Mammoth Cave and inside the Calgardup Cave, in the cave district, South-western Australia. The specimens from the latter were living absolutely in the dark.

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## CHERAPS PREISSII, var. ANGUSTUS, var. nov.

### PLATE XXXII.

This variety differs from the typical form only in having more slender chelipeds and legs, and a slightly narrower carapace. The chelae are particularly narrow in my smallest specimen, and in this respect differ greatly from others of the typical form of about the same size in which they are almost similar to those of the adults. The colour, after long preservation, is a dark violet with light bluish areas on the sides and under parts.

The plate illustrates the only three specimens I have seen which were collected for the Australian Museum by Mr. A. Abjornsen, near Albany. They are 141, 102, and 78 mm. long from the tip of the rostrum to the end of the telson, and the largest and smallest are females.

## CHERAPS QUINQUECARINATUS, Gray.

## PLATE XXXIII.

- Astacus quinque-carinatus*, Gray, in Eyre, Journ. Exped. Centr. Austr., I, 1845, p. 410, pl. III, fig. 3.  
*Astacus (Cheraps) quinquecarinatus*, Von Martens, Monatsbr. Akad. Wiss. Berlin, 1868 (1869), p. 616.  
*Astacopsis quinque-carinatus*, Haswell, Cat. Austr. Crust. 1882, p. 176.  
*Cheraps quinque-carinatus*, Smith, Proc. Zool. Soc., 1912, p. 165, pl. XXIII and XXVII, fig. 25-29.

I have examined thirty-eight specimens of all sizes between 45 and 131 mm. long, from the tip of the rostrum to the end of the telson, and find but little variation in the essential characters of this species. There are some differences in the form of the chelae, which consist chiefly of an alteration in the shape of the fingers, they being narrow and somewhat pointed in some, and much broader and more obtuse in others. A tomentose patch on the upper surface of the hand, near the inner margin, is usually present, but may be absent.

Carapace finely pitted above; large specimens with some very minute tubercles on the lower anterior parts of the sides. A row of enlarged tubercles behind the cervical groove. Back with five keels, of which two are backward extensions of the lateral margins of the rostrum. The median keel arises between these last, and may run backward to the cervical groove or terminate well before that point; the outer keels form two sharper or blunter points anteriorly. Rostrum either horizontal or rather obliquely deflexed not reaching the ends of the antennal scales; its sides are elevated, leaving the upper surface more or less concave. It ends in a spine, and there are usually two, rarely one or three denticulations on each side near the tip. Its length and breadth is subject to a little variation. Abdomen pitted but otherwise smooth.

Chelipeds rather massive. The hand is comparatively elongate, its breadth being always distinctly less than half its length. It is smooth and rounded above with small scattered pits, which are a little larger and more crowded on the outer surface; the two largest specimens have a narrow, irregular groove along the middle of the upper surface. The inner margin is raised with seven to nine serrations; usually there is a tomentose patch just within this margin. Fingers either meeting along their entire length, or with a larger or smaller gap between them. They are armed with one or

more small rounded tubercles on their inner margins which are scarcely developed in the smaller examples. Wrist with a sharp internal spine, and often several smaller ones near its base.

Such specimens as retain any traces of colour appear to have been purplish with minute pale dots on the chelae.

The material described above was collected at the following localities in South-western Australia:—Chidlow's Well, north-east of Perth; near Perth; Cannington, south of Perth; seven miles above Harvey, Harvey River; Korijekup, Harvey River. According to Mr. Alexander, this species, which is known as the gilgie, is probably restricted to the smaller streams which do not dry up in the summer. In addition to the above noted localities, he has identified specimens from the Vasse River.

## CHERAPS TENUIMANUS, Smith.

PLATES XXXIV & XXXV.

*Chaeraps tenuimanus*, Smith, Proc. Zool. Soc., 1912, pt. I., p. 166, pl. XXII., and pl. XXVII., fig. 30.

A well graduated series of forty specimens, ranging from 57-296 mm. long from the tip of the rostrum to the end of the telson, shows considerable variation in the form of the chelae and rostrum, as well as in the armature of the latter.

The chelae are always much more slender in young specimens than in adults, while large specimens always have the fingers bent more or less obliquely inwards. The teeth on the inner margin of the palm are scarcely developed in small specimens, but become very prominent in adults; there are usually seven or eight, but may be as few as three. Though these alterations are correlated with growth, yet specimens of the same size are not always equally changed, some retaining their juvenile characters longer than others. Some different forms of chelae are illustrated on plate XXXV.

The rostrum has from three to six denticulations on either side which, as often as not, are not paired but more or less alternate. Its length and breadth are also variable; it may reach well beyond the antennular peduncle, or only to the middle of the last joint, but it never attains the tip of the antennal scale. A few of the most striking variations shown in my series are figured on plate XXXV.

The following are the principal characters of the species.

Carapace finely pitted above; large specimens have numerous sub-acute tubercles on the back and sides behind the cervical groove which can be traced more or less distinctly in all but the smallest specimens. There are usually four sharp spines on the sides directly behind the cervical groove. Back with five keels, of which two are backward extensions of the lateral margins of the rostrum. The median keel rises between these last and may run back to the cervical groove, or terminate well before that point. The outer keels each end in an acute spine anteriorly. Rostrum nearly horizontal or obliquely smooth in younger specimens but with numerous large and rounded tubercles in adults.

Chelae slender in young, massive in adults; the breadth varies from more than four to about two-and-a-half in the length, according to age. They are smooth and rounded above, with minute scattered pits which are more crowded on the outer surface. The inner margin is not raised upwards, and is usually provided with seven or eight tubercular denticulations. There is no tomentose patch on the upper surface in any of my specimens. Fingers either meeting along their whole length or with a greater or smaller gape between them. They each have a large tubercle on the basal halves of their inner margins, with one or two smaller ones behind them. Wrist with a moderately large internal spine.

This large and handsome species is apparently confined to the rivers of South-western Australia. Of the series examined the greater number were obtained in the Harvey River, seven miles above Harvey; one is from Korijekup, Harvey River; one from Margaret River; one from Balingup Brook; and three from the Warren River. Mr. W. B. Alexander informs me that it is known as the Marron, and that he has also seen it from Kojonup.

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### Genus PARACHAERAPS, Smith.

#### PARACHAERAPS BICARINATUS, Gray.

*Parachaeraps bicarinatus*, (Gray) Smith, Proc. Zool. Soc. 1912, pt. I., p. 163, pl. XXI., and pl. XXVI., figs. 15-24.

Smith has described specimens of this species from Victoria, and states that "it is widely distributed all over Central, Northern, and Western Australia and in Queensland." Unfortunately, the

only definite localities he gives are a few in Eastern Australia. I am unable to find any records of its occurrence in Western Australia, though since it lives in the deserts of Central Australia, and at Port Essington it possibly extends into the central and northern parts of the Western State. As already stated it is not represented in a series of more than one hundred specimens from several widely separated localities in South-western Australia, its place being apparently taken by *Cheraps preissii* which resembles it both in appearance and in habits.

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## ON A SPECIMEN OF *REGALECUS GLESNE*. ASCAN. OBTAINED IN WESTERN AUSTRALIA.

-- BY --

W. B. ALEXANDER, M.A.

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### PLATE XXXVIII.

On January 8th, 1913, the Museum obtained through Captain A. Abjornssen, Inspector of Fisheries, a fine specimen of an Oar-fish. It had been found on the shore of Rottnest Island a few days previously in a dying condition by a boy named Backhouse. As this curious fish is so rarely met with, as some doubt exists as to whether there is only one cosmopolitan species of Oar-fish, or whether there are a number of closely allied forms, and as this is the first authenticated record for the west coast of Australia, it seems worth while to give a short description of the present example.

Before doing so it will be well to notice briefly the records of previous occurrences of *Regalecus* in Australasian waters. The first example seems to have been obtained at Nelson, N.Z., in 1860, and since then some 15 other examples have been recorded from New Zealand. Of these, three are of special interest since they were made types of new species.

One obtained at New Brighton near Christchurch in 1876 was described by von Haast as *R. pacificus* (Trans. N.Z. Inst. X., p. 246) whilst one obtained at Moeraki in Otago Harbour was described by Parker as *R. argenteus* (Trans. N.Z. Inst., XVI, p. 284). Another, also obtained in Otago Harbour was made the type of *R. parkeri* by Benham (Trans. N.Z. Inst., XXXVI, p. 198). Other New Zealand specimens have been referred to *R. gladius* and *R. grillii*.

I can only find references to four previous occurrences of *Regalecus* in Australia, all from the East or South-east. The first obtained in Bass Strait in 1878 was described and figured by McCoy (Prodr. Zool. Vict., vol. II., p. 169) under the name of *R. banksi*. The second, found on the beach in the Tweed River District of Queensland, was made the type of a new species, *R. masterii*, by de Vis (Proc. Roy. Soc. Q'land, 1892, p. 109). The



third, obtained at Shark Beach in Port Jackson, N.S.W., in 1899, was described under the name of *R. glesne* by E. R. Waite (Rec. Austr. Mus., III, p. 163), whilst it appears that a fourth was stranded below the lighthouse at Cape Everard, in Victoria, in 1896 (Melbourne *Leader*, Aug. 1, 1896, p. 7). The present is therefore the fifth Australian specimen to be recorded in print, but from information obtained by Mr. O. Lipfert it would appear that a specimen was washed up on the beach at Bunbury, W.A., some ten or twelve years ago. Mr. Lipfert's informant states that he was on the beach with one or two other men when they observed the fish swimming on the surface, that as it neared the shore a shark bit the middle portion of the body right through, that the two halves were soon afterwards washed upon the beach and that he had the long oar-bones in his possession for many years afterwards.

The only specimen of *Regalecus* which has previously been recorded from the Indian Ocean was obtained at Vizagapatnam, in March, 1788. It remains the unique specimen of *Regalecus russellii*, Shaw, characterised especially by the presence of a distinct caudal fin. As it was only 2 feet 8 inches long it is possible that *R. russellii* was founded on a very young example and that the caudal fin is lost in later life. The tail is, however, so fragile that very few, if any, other examples have been obtained in which it is perfect.

Most recent authorities who have dealt with the genus have agreed that it is better to regard all the examples known, with the possible exception of *R. russellii*, as forms of one variable species, *R. glesne*, Ascan.

The present example falls within the limits of variability assigned to this species by Goode and Bean in their "Oceanic Ichthyology" in all respects, except the smaller number of dorsal rays, but it would not agree with any one of the other species described from Australasia.

As in most other examples our specimen was not perfect, as the fragile crest, the long ventral fins and the tip of the tail were all broken. The two former breakages had evidently occurred when the fish was washed ashore, and portions of the crest and oars were obtained with the fish. The tail, however had been broken at some former period, within a few inches of the tip and had subsequently healed.

The specimen is a comparatively small one, the total length being nine feet seven inches.

The following features are those in which different examples of *Regalecus* vary :—

Height from  $1/12$  to  $1/24$  of the length (Goode and Bean); the present example was  $8\frac{3}{4}$  inches in height and 9 ft. 7 ins. long, hence the height was  $1/13$  of the length.

Length of the head contained from 16 to 20 times in the length of the body (Goode and Bean); the present example had a head 7 inches long, or  $1/16$  of the length of the body.

Teeth minute or absent (Goode and Bean); in this case they are absent.

Diameter of eye 4 to 6 times in length of head (Goode and Bean); the eye has a diameter of  $1\frac{1}{4}$  inches or 5.6 times in length of head.

Dorsal rays 275 to 400 (Goode and Bean); our specimen has only 205 dorsal rays, and the small missing portion of the tail could not possibly have borne more than another 20.

Pectoral rays 11 to 14 (Goode and Bean); they are 12 in this example.

Goode and Bean also state that the skin has numerous bony tubercles. Parker points out in his description of *R. argenteus* that the tubercles which appear to be bony as long as the skin is moist, disappear when it is allowed to become completely dry. I found that this was the case with the present specimen.

The bases of the rays of the crest also agree precisely in their arrangement and relative thickness with those so caerfully described by Parker (loc. cit. and Trans. N.Z. Inst., XX, p. 20.)

On the other hand, the shapes and relative sizes of the opercular bones differ very markedly from those figured by Parker, and indeed from those in all the other figures which I have been able to find. The accompanying photographic illustration will show this better than I can describe it (cf. Benham, P.Z.S., 1906, p. 544.)

Unfortunately I was absent when the specimen reached the Museum and the sex was not determined nor the contents of the stomach noted. A plaster cast was prepared and the missing fins added and coloured from the details given by Clarke (Trans. N.Z. Inst., XXX, p. 253). The head and skin are preserved in the Museum collection. (Registered No. P 23).

## A BRACHIOPOD NEW TO AUSTRALIAN WATERS.

— BY —

W. B. ALEXANDER, M.A.

On July 26, 1913, I visited Cottesloe Beach to look for marine animals which might have been washed up by the stormy weather of the earlier part of the week. My search was well rewarded by the discovery of a Brachiopod shell in good condition which I was able to identify from Davidson's work on "Recent Brachiopoda" as *Terebratulina radiata*, Reeve.

The species is characterised by the pair of ribs which run forwards along the dorsal valve, separated by a deep groove. On the ventral valve the middle line is occupied by a strong rib, with a groove on each side. The deltidial plates in my specimen are united, thus completing the foramen; Davidson states that this condition "appears to be the exception and not the rule." My specimen is 11 lines long, 8 broad and 6 deep; these dimensions agree with those given by Davidson except that for breadth, which he gives at 9 lines. He states, however that he had seen "a great many specimens of the shell, some as wide as long, others longer than wide", so that the width is a very variable feature.

It is possible that this species is really a variety of *Terebratulina cancellata*, Koch, which appears to be the only Brachiopod previously recorded from Western Australia, from which country the type-specimens were said to have been brought previous to 1843. This latter species occurs on the coasts of New South Wales, Tasmania and South Australia, and one would suppose that if *T. radiata* were only a variety of that species it would have been found with it in the other States.

Davidson says on this subject: "Mr. Lovell Reeve considers this to be a good and well-marked species, and in this statement I feel disposed to concur. I have seen a great many specimens of the shell . . . all presenting a more or less well-marked bipli-cation. It is a smaller shell than *T. cancellata*, its nearest ally."

The latter attains a length of 1 inch 7 lines. With regard to habitat, Davidson states: "Mr Cuming possesses two or three specimens, all exactly alike, procured, he fancies, from the dredgings of Sir E. Belcher in the Strait of Corea. I have seen and possess a number of specimens of this shell, which Mr Sowerby assures me were obtained near the Cape of Good Hope, its probable habitat."

Since Davidson's work was published 25 years ago, it is quite possible that the species may have been found in the interval. I have looked through the papers dealing with Australian Brachio-poda by Dr. Verco and Mr. Hedley, neither of whom records this species in the lists for other parts of Australia. I think, therefore, that I can safely claim *Terebratulina radiata*, Reeve, as a species new not only to this State, but to the whole of Australia.

## A NEW SPECIES OF EMBIID FROM WESTERN AUSTRALIA

— BY —

Dr. K. FRIEDERICHS (Apia, Samoa).

*(The English translation has not been revised by the Author).*

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The following description is founded on two dry examples which I received for identification from the Western Australian Museum at Perth.

### OLIGOTOMA HARDYI, n. sp.

Male. Winged. Posterior branch of the radial ramus<sup>1</sup> not forked in either wing, rather strongly developed, but not reaching the tip of the wing; the same remarks apply to the median, whilst the cubital is absent. Anal present.

The wing-veins which are present, as well as the line of the absent cubital, are brown-edged; so that, apart from the anal, five double brown longitudinal lines are present and the wings look rather darkly striped to the naked eye.

Transverse veins numerous. In the forewing six between the anterior margin of the wing and the first radial branch (these are only weak, the rest are stronger); four between the first and second radial branches; three between the latter and its successor; and two in the space to the median. In the hindwing the corresponding numbers are: three, four, two, two. As in the other species the number of transverse veins varies. This species may be said to have much better developed wing-veins than all other known species.

Antennae with 21 segments. Eyes large, projecting, kidney-shaped, broader than long (as seen from above). The whole head about  $4\frac{1}{2}$  times as long as the eye. Lateral borders of the head converging posteriorly and slightly rounded.

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<sup>1</sup> The terminology employed is that of Enderlein's Monograph of the Embiidae.

Prothorax somewhat narrower than the posterior margin of the head, the apotom separated off by a distinct constriction. Meso- and meta-notum naked (the rest of the body covered with stiff hairs.)

Legs without peculiarities (so far as I could ascertain from these dry specimens). Front tarsi with the normal oval metatarsus, convex above, for use in spinning.

**Extremity of the abdomen;** 10th tergite divided longitudinally; the right half produced into a long pointed process, the left with a short round termination. The appendage of the 9th sternite (penis?) projects straight back and appears to be bifid; its anterior portion is hidden by the middle part of the 10th tergite. Basipodite of the left cercus flattened, produced inwards; the first joint of the left cercus strongly club-shaped, posterior half produced inwards and toothed on that side; the second joint short, thick and cylindrical. (It is difficult to determine the precise structure of the extremity of the abdomen in dry specimens).

**Colour.**—Dark brown, meso and meta-notum and parts of the legs lighter; the first segments of the antennae yellowish brown.

**Dimensions.**—Specimen 1—length  $11\frac{1}{2}$  mm.

Specimen 2—length 10 mm.

Wings the same size in both specimens—length 11-10 mm., breadth  $2\frac{1}{2}$ - $2\frac{1}{4}$  mm.

**Habitat.**—Western Australia. Captured in Perth by Mr. G. H. Hardy, now at the Tasmanian Museum, Hobart. They flew into a room in company with several other individuals attracted by the light of a lamp in June, 1912.

**Remarks.**—This species does not agree with the diagnosis of the genus *Oligotoma* given in either of the Monographs (those of Krauss and Enderlein). Yet, there is no doubt that *O. hardyi* is an *Oligotoma*.

It differs from Enderlein's diagnosis in the strong development of the median and the posterior branches of the radial ramus, and in the absence of a process on the left half of the 10th tergite. From Krauss' diagnosis it differs in possessing teeth on the much-thickened first joint of the left cercus. *O. heymonsi*, End., also differs from this diagnosis in having the same organ toothed, whilst in *O. greeniana*, End., the left process of the 10th tergite is also absent.

Whilst in Sydney I had the opportunity of examining the type (male) of Froggatt's Australian Embiid (*O. gurneyi*) in the Agricultural Museum. It is a dry specimen without an abdomen. The neuration characterises the species as an *Oligotoma*. From the present species it may be distinguished by its smaller size and lighter colour (the whole body is light brown, the head no darker than the thorax) as well as by the wing-veins. The (unforked) posterior portion of the radial ramus is only well-developed at its proximal end, the remaining part being only faintly indicated. The same is true of the median and the cubitus. The eye as seen from above is almost circular (as in Enderlein's figure of *O. saundersi*). It is possible that it may be one of the cosmopolitan species (*saundersi* or *latreillei*) but a reliable identification of this specimen is obviously out of the question.

## THE MAMMOTH CAVE

(Continued).

By LUDWIG GLAUERT, F.G.S., ETC.

ORDER MONOTREMATA. Fam. TACHYGLOSSIDAE.

*Zaglossus* Gill (1877).<sup>1</sup>*Proechidna*, Gervais .. Ostéog. Monot. Viv. et Foss., p. 43, 1877.*Acanthoglossus*, Gervais .. Comptes Rendus, Paris LXXXV No. 19, p. 838, 1877.*Bruijnia*, Dubois .. Bull. Soc. Zool. Franc. VI for 1881. No. 6, p. 267-270, 1882.

## ZAGLOSSUS HACKETTI, sp. nov.

HACKETT'S GIANT ECHIDNA.

PLATES XXXVI-XXXVII.

The bones about to be described were collected in the Mammoth Cave, where they were found intermingled with the remains of *Sthenurns*, *Macropus*, etc., in the older portion of the deposit first examined in 1909.

They comprise the atlas vertebra, the clavicles and episternum, the pelvic girdle, two femora, a tibia and a radius.

The limb bones are all twice the length of those of the living species of *Echidna* (*Tachyglossus aculeatus*) and in addition are stouter in proportion. The bones of the trunk show a similar superiority in dimensions.

Fossil *Echidnas* of large size have been known in Australia for many years. In 1868<sup>2</sup> Krefft described the proximal end of a humerus which he named *Echidna oweni*, and in 1884<sup>3</sup> Prof. Owen examined the cast of a more perfect example (*E. ramsayi*) which is now regarded as identical with the former species, to which have also been ascribed the other remains of large fossil *Echidnas* in the Australian Museum, Sydney. In 1895<sup>4</sup> Mr. W. S. Dun fully described the imperfect skull and atlas vertebra of a larger animal, which he named *Echidna* (*Proechidna*) *robusta*.

<sup>1</sup> Ann. Record Science and Industry for 1876, p. clxxi, which appeared on May 5th, 1877. Gervais Ostéog. Monotrèmes Viv. et Foss., p. 43, was published on Nov. 30th, 1877, hence Gill's name has priority over that proposed by Gervais. *Fide* Palmer.

<sup>2</sup> Ann. Mag. Nat. Hist. (4) Vol. 1, p. 113 (1863).

<sup>3</sup> Phil. Trans. 1884, p. 273.

<sup>4</sup> Rec. Geol. Surv. N.S. Wales, vol. IV, part 3, p. 121 (1895).



## DESCRIPTION OF THE REMAINS.

The atlas vertebra is perfect, its inferior arch completely ossified and the transverse processes fused to the rest of the vertebra. Its neural arch is well developed antero-posteriorly, it has a steeply inclined anterior surface and a gradually sloping posterior one. The neural spine is represented by an anteriorly directed tubercle from the base of which a rounded ridge extends to the anterior border of the transverse processes. The greatest width of the anterior surface of the arch is but 6.5 mm. compared with 10.5 in *E. (P.) robusta*. The extent of the posterior surface, measured from the tip of the neural spine to the posterior margin is 15 mm., the arch is not as flat as in Dun's specimen and is much more slender, although it helps to form a larger concavity for the reception of the odontoid process of the axis. The inferior arch is slender and agrees with Dun's figures,<sup>1</sup> but the curve is not quite so regular, resembling *Tachyglossus* in this respect. Both the anterior zygapophyses are large, irregular in outline, with an anterior lobe, their lower end passes imperceptibly into the inferior arch. They are concave vertically and almost flat horizontally. The posterior zygapophyses are ear shaped and possess well-marked posterior lobes; downwards they merge gradually into the inferior arch, their apex projects from the lateral mass to a marked degree: they are but slightly concave vertically and horizontally. The transverse processes are complete, they extend outward and backward with a slight downward curve and a well marked ridge on their external border; there is a slight concavity in the anterior region of their upper surface, but the main mass of each process is convex above and below.

The area bounded by the neural and inferior arches is deeper and broader than in *E. (P.) robusta*. The extreme width of the vertebra, including the transverse processes is 59 mm. and the height to the tip of the neural tubercle 33 mm.

The united clavicles and episternum form a bow-shaped mass whose constituents are completely fused, rendering it impossible to distinguish the individual clavicles and the upper part of the T-shaped episternum. It is roughly trihedral in section, the well marked antero-superior ridge gradually passing downwards to the

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<sup>1</sup> *Loc. cit.* pl. XI, figs. 5 and 6.

origin of the vertical member of the episternum. The inferior and the postero-superior angles are more rounded and constant in position.

The imperfect pelvic girdle comprises two fused sacral vertebrae and part of the right innominate bone with the complete, perforated articular cavity and the adjacent portions of the ilium and ischium. The sacral vertebrae, the second and third of the series, have marked intervertebral cavities and their neural spines fused together at their tips, the neural arches also send out bony processes forwards and backwards to completely cover the neural canal. There are the usual lateral openings for the passage of the nerves. The anterior vertebra is attached to the ilium by the usual lateral growths from centrum and neural arch and the posterior one by the pleurapophysial ossification only. The vertebrarterial passage on the right side is larger than the neural canal.

The ilium is trihedral; its fusion with the other components of the innominate bone complete, its acetabular border short and concave, with the prominence for the attachment of the rectus (extensor) muscle of the leg forming a prominent compressed sub-lunate area close to the rim of the acetabulum—in the Australian *Tachyglossus* this surface is markedly triangular. The acetabulum is large, more ovate than in *Tachyglossus*, somewhat flattened on the dorsal surface, incompletely ossified but with an entire margin; its dimensions are 40 mm. x 34 mm. The pubis has a well-marked pectineal process which is comparatively more developed in *Tachyglossus*. Very little of the broad flat ischium is preserved.

Both femora are present in the collection. The complete right one (plate XXXVI, fig. 1) is short and broad, flattened from before backwards with a well defined head that rises but little above the great trochanter on a short and indistinct neck; in this it differs from the femur of *T. a. ineptus* (plate XXXVI, fig. 2), and from the fossil *Z. (Echidna) oweni* specimen F13580 of the Australian Museum, represented in this collection by a cast, whose heads rise considerably above the trochanter. The great trochanter is much more massive than in the living form and gives rise to a strong, rough, projecting ridge that extends along two-thirds of the shaft, where it ends abruptly. The lesser trochanter on the inner side of

the shaft is situated more distally than in the living *Echidna*, rising sharply at a point 20 mm. from the head, from this point a well-defined ridge runs to the distal end of the shaft.

At the longitudinally compressed, and transversely expanded distal extremity, the trochlear articular surface is well marked, in front it is slightly curved transversely and convex vertically, posteriorly it is divided into two condyles by a wide and deep intercondylar notch, which in comparison is deeper and broader than in the living *Echidna*.

The tibia (plate XXXVII) is straight, laterally expanded at the proximal and distal ends with a relatively slender shaft; the anterior convexity of the proximal end of the shaft (the tuberosity for the tendons of the extensor muscles) is separated from the lateral expansions by two shallow grooves which gradually diminish as the shaft becomes more slender, till finally the anterior surface becomes a regular convexity.

At the distal end of the bone and at some distance above it on the posterior aspect (plate XXXVII, fig. 3) the concavities and convexities for the reception of the bones of the ankle joint and of the adjacent fibula are very prominent; they show no material difference in arrangement from the corresponding features in the *Echidna T. a. ineptus* represented in the Museum Collection.

The fore limb is represented by the right radius only. The bone is more slender than the tibia, has its heads much expanded laterally; these are excessively developed in directions at right angles to one another. The oval hollow for the reception of the humerus is deep with a marked thickening at its posterior margin. The distal end has two concavities separated by a convex ridge to fit into the convexities of the scapholunar, and the small sesamoid bone developed in the tendon of the flexor carpi radialis, the concavities are sub-equal, but in *Tachyglossus aculeatus ineptus*, the living species of Western Australia, the outer one is much the larger. The interosseous ridge and the tracts for the attachment of the muscles are also situated more distally, but the most noticeable difference between the species is the extreme robustness of the fossil form.

The minimum antero-posterior diameter of the radius of the living species is 3.5 mm., whereas, in the bone of the fossil species

which is approximately twice the length, the least diameter in the same direction is 9.5 mm., the other dimensions of the shaft are in proportion.

On account of this striking characteristic noted in all the bones at present collected, and of its excess in size over the largest known forms, it is proposed to regard this animal from the Mammoth Cave as the type of a new species to which the name of *Zaglossus hacketti* has been given, in honour of Sir J. Winthrop Hackett, K.C.M.G., etc., the President of the Board of Trustees, as a slight acknowledgement of his generous support which alone rendered the exploration of these caves possible.

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ORDER MARSUPIALIA.

SUB-ORDER POLYPROTODONTIA.

Family DASYURIDAE

Sub-Family DASYURINAE.

*Thylacynus*, Temm. (1827)<sup>1</sup>

## THYLACYNUS CYNOCEPHALUS, Harris (1808)<sup>2</sup>

### THE TASMANIAN WOLF OR TIGER.

An interesting specimen from the upper layer<sup>3</sup> in the Mammoth Cave consists of an almost complete left mandible with four cheek teeth in position. Of these teeth two premolars, p<sub>3</sub> and p<sub>4</sub> have been subjected to a certain amount of wear; the molars m<sub>1</sub> and m<sub>2</sub> are missing, but m<sub>3</sub> is present, rising from its alveolus, and the last cheek tooth m<sub>4</sub> is still in its formative cavity.

The general outline of the ramus is similar to that of *Thylacynus*; it is slender and is slightly curved horizontally with its convexity downwards. The coronoid is short and delicate with a thickened anterior margin, the angle of the jaw is large, broad and prominent. The condyle is strong, broad transversely and has its upper surface below the line of the crests of the teeth; it is separated from the coronoid by a deep notch.

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<sup>1</sup> Mon: Mammalogie, Vol. I, 3<sup>e</sup> Mon: pp XXIII, 23-24 footnote, 267, pl. 7, figs. 1-4, on pages 60-65 of the same volume the spelling is *Thylacinus*. Trouessart Cat. Mamm. Vol. II, p. 1216 (1898/9) does not include the form *Thylacinus* in the synonymy of the genus *Thylacynus*, regarding it as a misprint.

<sup>2</sup> Trans. Linn. Soc. IX, p. 174, pl. 19 (1808).

<sup>3</sup> *vide ante* p. 12.

The dentition is imperfect, it is possible to recognise the sockets of three incisors, one canine, one small premolar in advance of the two still present and two molars between these two teeth and the rising  $m_3$ .

The premolars resemble the corresponding teeth of *Thylacynus cynocephalus*; they are much longer than broad, sharp and pointed, the blade is curved slightly backwards and inwards, the posterior ledge cusplless.  $P_4$  is considerably larger than  $p_3$ .

The molar  $m_3$  is slender and narrow; it consists of a sharp, slightly incurved central cusp, a small anterior cusp and a less developed posterior one associated with which is a rudimentary postero-internal swelling. The posterior cusp is broader than the anterior one and has a subquadrate, not triangular outline. The two main secondary cusps are in contact with the central one on the outer surface. This tooth also more nearly approaches the type of the genus *Thylacynus* than that of the closely related *Sarcophilus*.

On account of its general outline the jaw cannot be regarded as that of *Sarcophilus*, whilst the crowded nature of the teeth, which however may be regarded as an individual character in a young animal, distinguishes it from *Thylacynus*, to which it has nevertheless been ascribed on account of the numerous resemblances the fossil bears to a typical Tasmanian Tiger or Wolf, *Thylacynus cynocephalus*.

A fragment of an atlas vertebra and an imperfect humerus of *Thylacynus* probably of the same animal were found associated with the mandible. A fragment of the skull with several cheek teeth *in situ* was obtained in the Museum Cave in November, 1912.

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SARCOPHILUS, Cuv. (1838).<sup>1</sup>

SARCOPHILUS HARRISI, Boitard (1842).<sup>2</sup>

THE TASMANIAN DEVIL.

Some time ago Mr. T. Connelly, the Caretaker of the Margaret River Caves, whilst undertaking explorations in the Bride's Cave,

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<sup>1</sup> *Vide ante*, p. 40 footnote. <sup>1</sup>

<sup>2</sup> Jardin des Plantes, p. 290, 1842, *vide* Oldfield Thomas, Proc. Biol. Soc. Washington, vol. XXV, pp. 115-118. June 29th, 1912.

which is some three or four miles south of the Mammoth Cave, discovered an unfamiliar skull lying uncovered upon a large talus of coarse sand and fragments of limestone and stalactite.

When Mr. W. B. Alexander, M.A., of this Museum, visited the locality in October, 1912, he noticed the striking difference between this skull and those of known indigenous mammals of the district, and therefore made a rough sketch of the specimen, as he was unable to remove it from the Cave. This sketch was subsequently shown to me and I was able to report that the remains were those of some species of *Sarcophilus*.

In November, 1912, I was instructed to proceed to the Caves in order to obtain this specimen and to collect, among other things, as many remains as possible from this and other Caves in the neighbourhood within the time at my disposal.

Soon after my arrival in the area, the Bride's Cave was visited and the skull removed from its precarious position. A large amount of sand and debris in the vicinity of the discovery was carefully sifted and examined, with the result that a small fragment of the lower jaw, with a molar *in situ* and several limb bones, presumably of the same animal, are now in the Museum Collection.

The bones are all in a fragile state and are not at all mineralised, suggesting that the animal was entombed within comparatively recent times. The bones adhere to the tongue as do those of the extinct *Phascolomys hacketti* from the Mammoth Cave, with which they may perhaps be considered contemporaneous.

The skull is not quite perfect, the left zygomatic process and the left auditory bulla are damaged, and the incisors and canines wanting.

An interesting feature in connection with this specimen is the abnormal outline of some of the bones of the nasal region; the left and right nasals and the right maxilla and premaxilla being the bones affected. Apparently at some period of the animal's life the bones on the right side of the muzzle were crushed and broken, parts of the right nasal being lost. In consequence of nature's attempt to repair the damage, a secondary growth of the maxilla extends to the median line of the skull, thus separating the anterior and posterior portions of the broken nasal and confining the area of the upper extension of the premaxilla, a detached piece of which seems to occupy the position of a lost fragment of the nasal.

The skull is larger than any preserved in this Museum but is slightly smaller than one from Tasmania, of which the measurements are given on p. 261 of the B. M. Catalogue of Marsupialia and Monotremata; on the other hand, it has a longer nasal bone, a larger palatal foramen, a wider construction and a much smaller  $m_4$  than the specimen in the British Museum, points of difference which may be safely regarded as due to individual variation and the greater age of the Tasmanian animal described by Mr. Thomas.

In addition to this cranium the Bride's Cave has yielded a fragment of the right mandible with an imperfect  $m_3$  *in situ* and the incomplete socket of  $m_2$  and the following limb bones, right humerus, right ulna, right femur, the distal end of the left femur and the left fibula. All these bones represent an animal that is not yet full-grown.

Remains of the Tasmanian Devil have been found in parts of Eastern Australia and the animal itself has been recorded recently from Tooborac beyond Kilmore about 63 miles from Melbourne<sup>1</sup> where a large female was killed in September, 1912, and sent to the National Museum, Melbourne. It would therefore appear that this creature, long regarded as extinct on the Australian mainland, may still inhabit certain wild and secluded districts, rarely, if ever, visited by man.

Measurements of the large male skull in the Collection of the British Museum (Natural History) from Tasmania, and of the skull from the Bride's Cave, Margaret River, South-Western Australia, with the percentage proportions of the latter to the former :—

	B.M. Cat. p. 261.	Bride's Cave.	Proportions.
Basal length .. .. .	123	114	92.7
Greatest breadth .. .. .	104	99 approx	95.1
Nasals, length .. .. .	51	52	101.95
„ greatest breadth .. .. .	20	19.5	97.5
Constriction, breadth .. .. .	17.5	17.5	100.0
Palate, length .. .. .	75	70	93.3
„ width between outer corners of $M_3$	62	53.7	86.6
Palatal foramen .. .. .	6.7	13.5 immaterial, depends upon age	..
Basi-Cranial axis .. .. .	38	35.5	93.4
Basi-Facial .. .. .	85	79	92.94
Facial index .. .. .	224	222.5	99.3
Teeth length, $p_3$ .. .. .	6.8	6.5	95.6
„ „ $p_4$ .. .. .	..	..	..
„ „ $m_1-3$ .. .. .	35.2	32.5	92.3
„ breadth, $m_4$ .. .. .	9.5	6.	52.0

<sup>1</sup> J. A. Kershow, Vic. Nat. XXIX, p. 76, 1912.

## FURTHER IMPORTANT DISCOVERIES IN THE MAMMOTH CAVE.

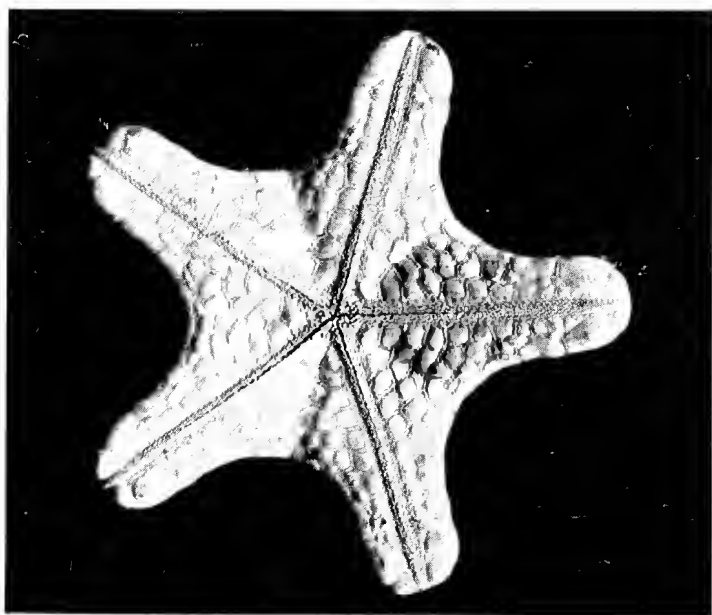
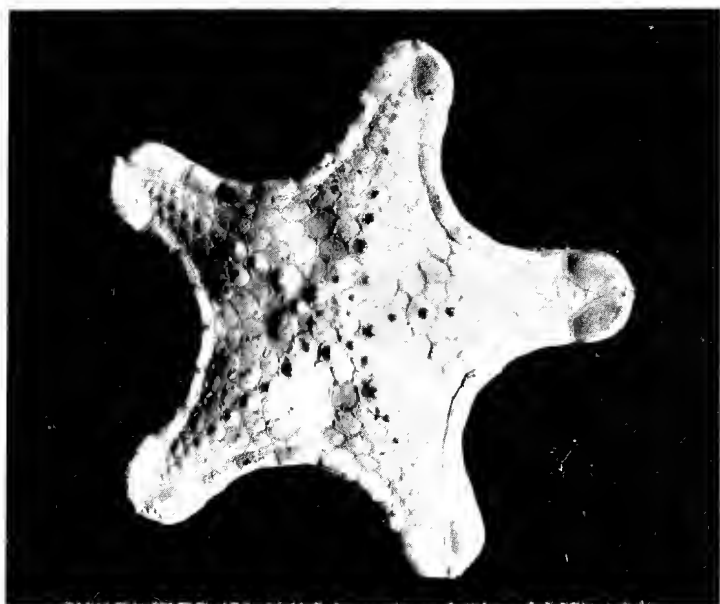
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The discoveries made by Mr. Glauert in 1909 and again in 1912 were of such great scientific interest that we were most anxious that the investigations should be continued, and therefore applied for permission from the Tourist Department in whose charge the Caves are placed. This was granted at once and every facility given Mr. Glauert to continue the work. We then appealed to the public for funds who responded generously. The President, The Hon. Sir J. Winthrop Hackett, K.C.M.G., who had defrayed the entire cost of the 1912 expedition, headed the list, and we were enabled to instruct Mr. Glauert to proceed to the Mammoth Cave and continue his researches for the space of three months. During this time he unearthed and forwarded to the Museum about 10,000 bones and fragments of bones, many consisting of jaws and teeth in an excellent condition of preservation. The genera represented comprised:—*Nototherium*, *Phascolomys*, *Phascolarctus*, *Sthenurus*, *Macropus*, *Bettongia*, *Dasyurus*, *Thalacomys*, *Perameles*, *Isodon*, and *Tachyglossus*. There were also specimens of *Muridae* and of reptiles and birds. Of special interest are the skeletal bones of *Nototherium* which show that the animal bears a much closer resemblance to *Diprotodon* than is generally supposed to be the case. There are two perfect skulls of *Sthenurus*. A description of these will shortly be published in the fourth part of the Records which will complete Volume I.

EDITOR.

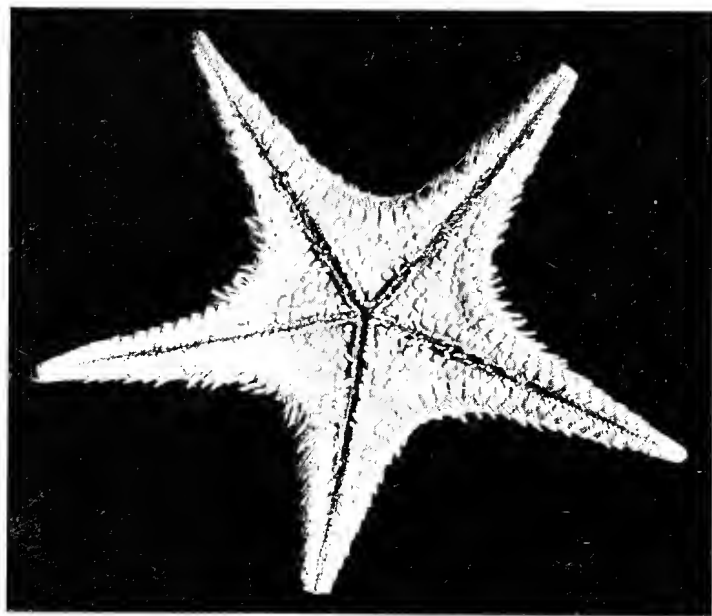
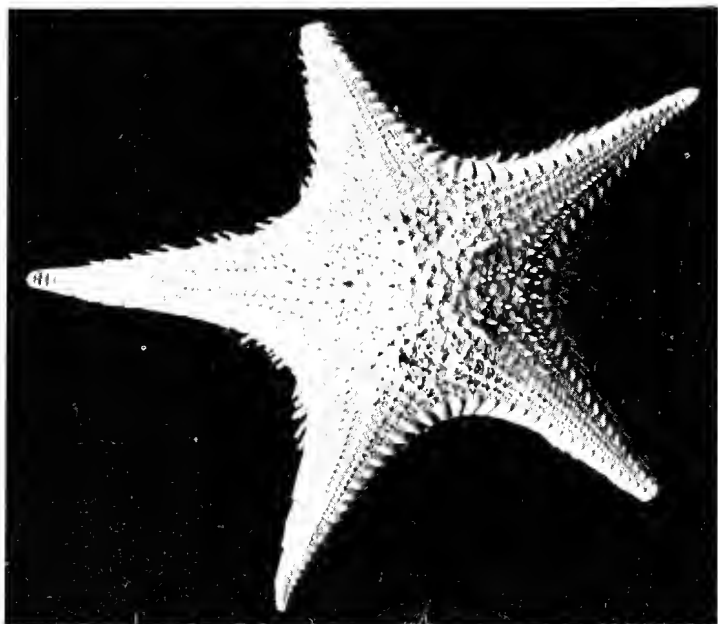






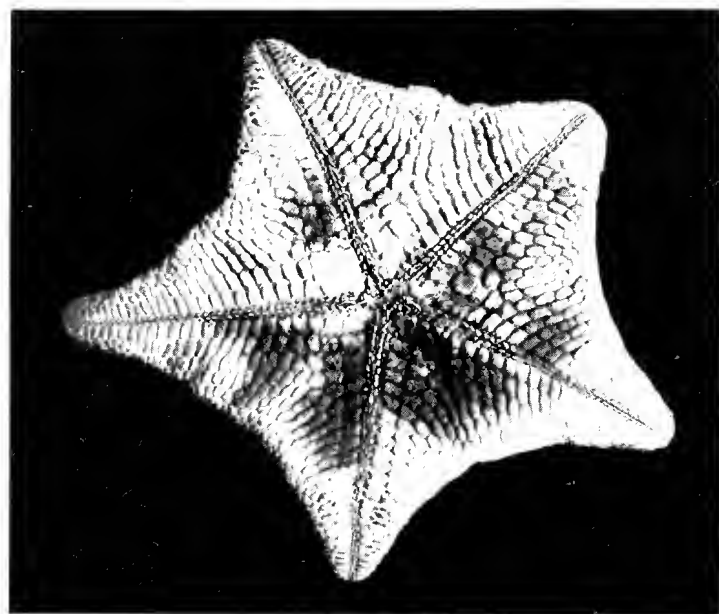
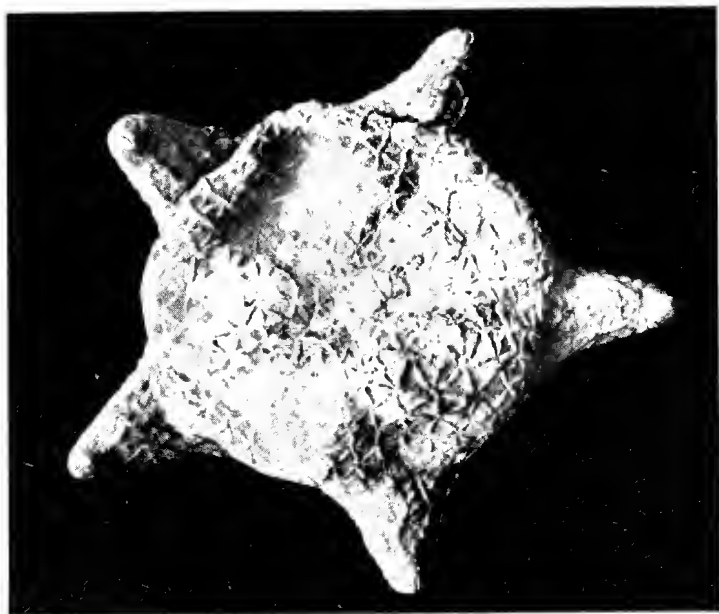
*Pentagonaster stibarus.*





*Stellaster megalocephalus.*

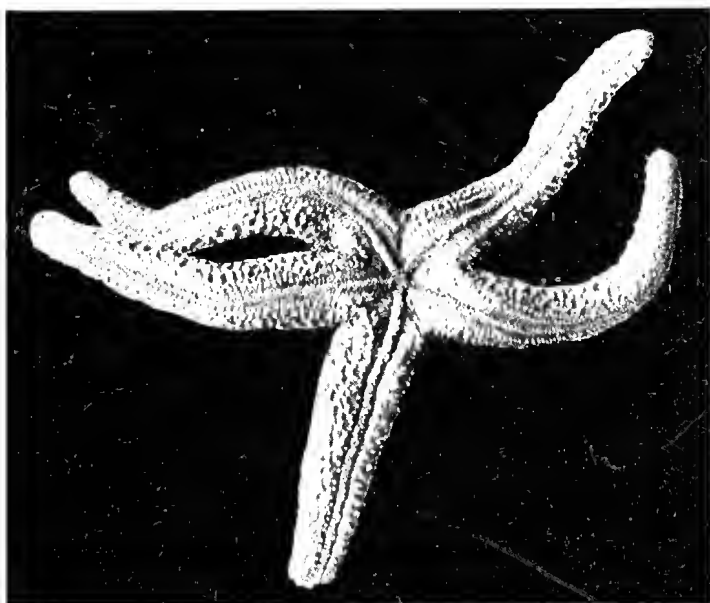
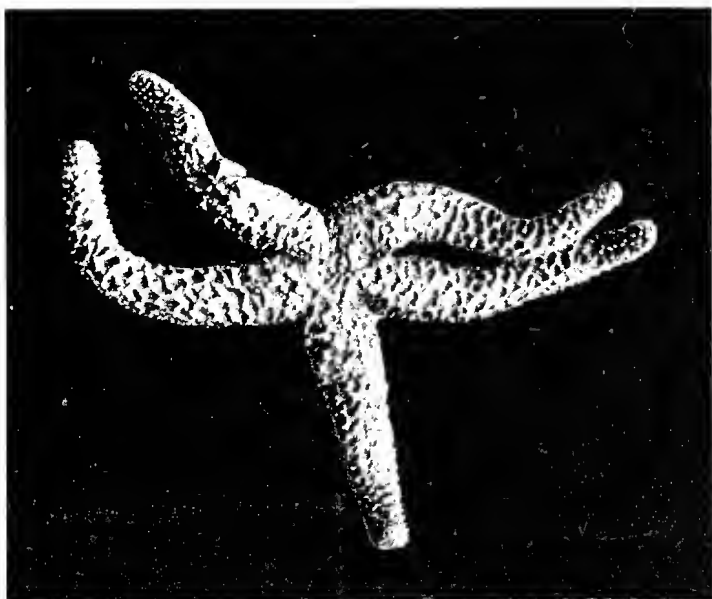




*Calcitaster anamesus*

PLATE XIX.

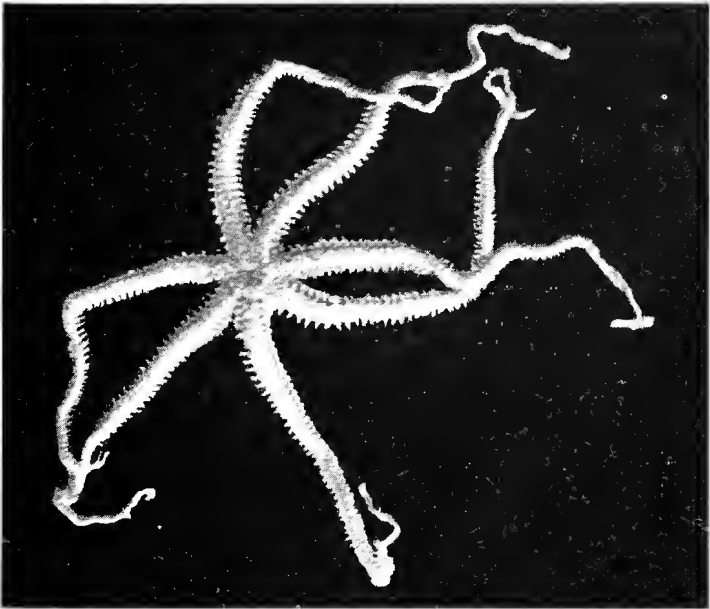
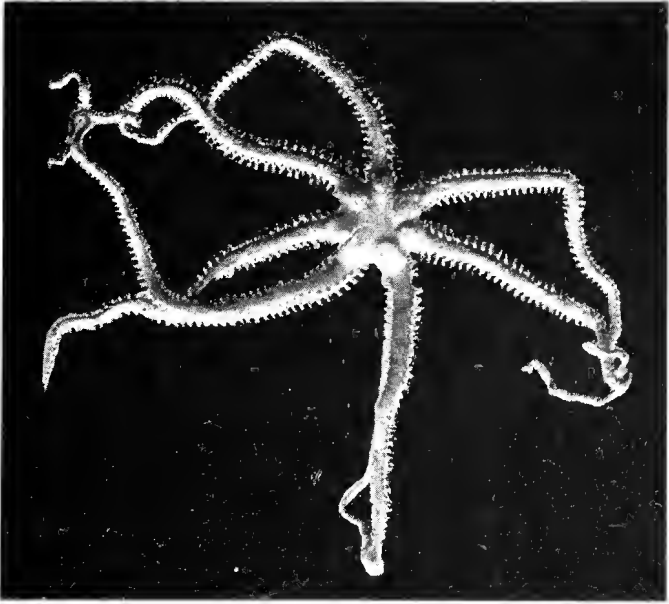




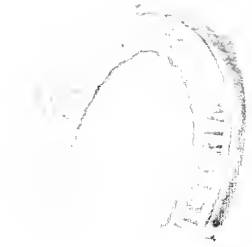
*Echinaster arcylatus.*

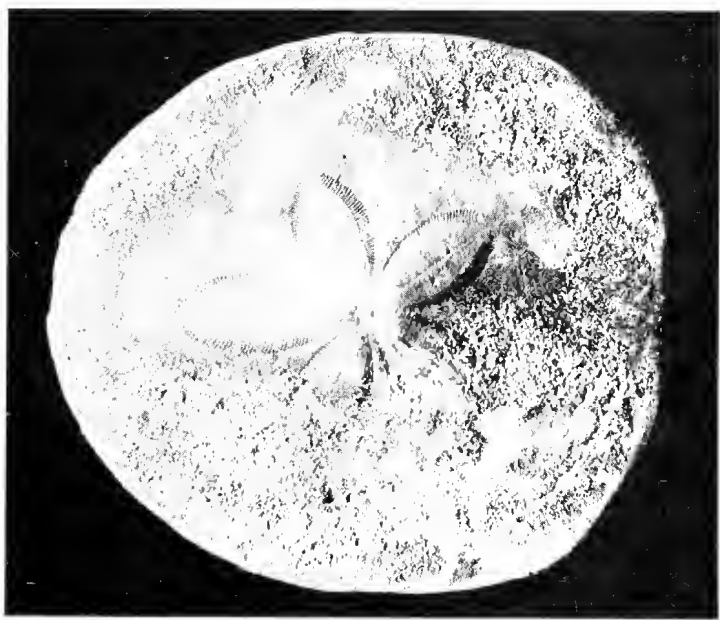
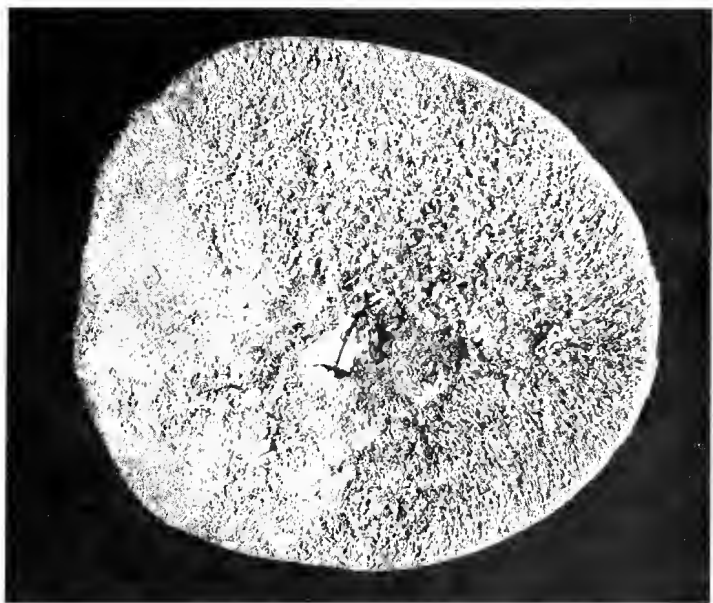






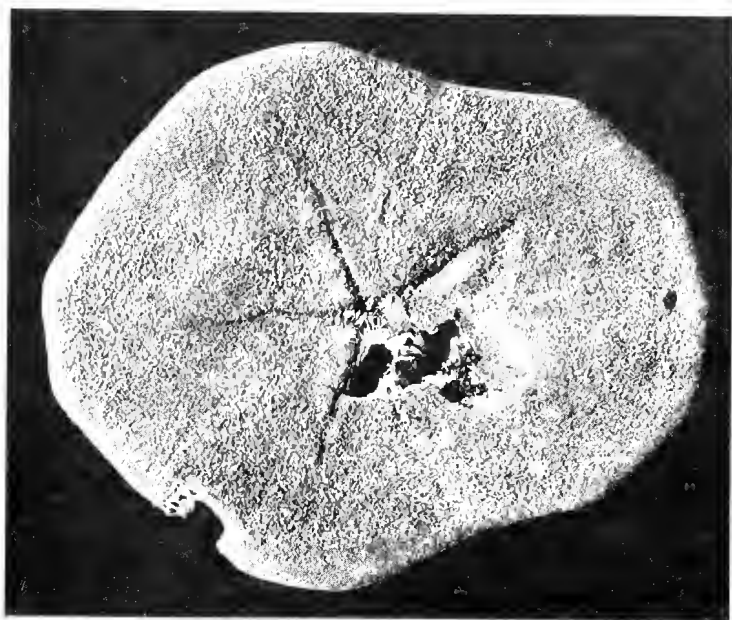
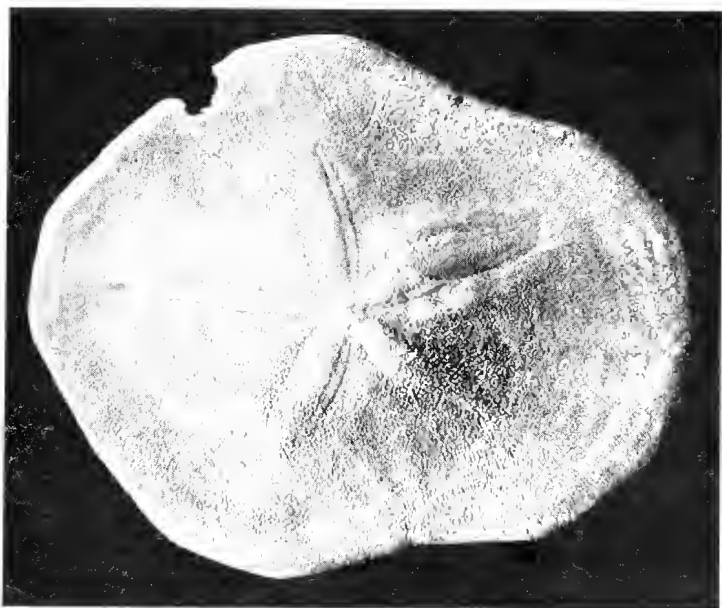
*Astrogymnutes calasticta.*





*Clypeaster telurus.*

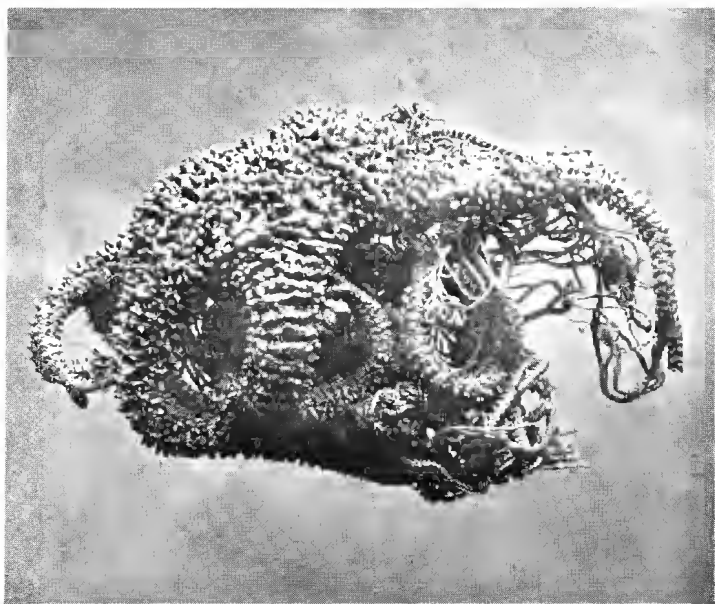




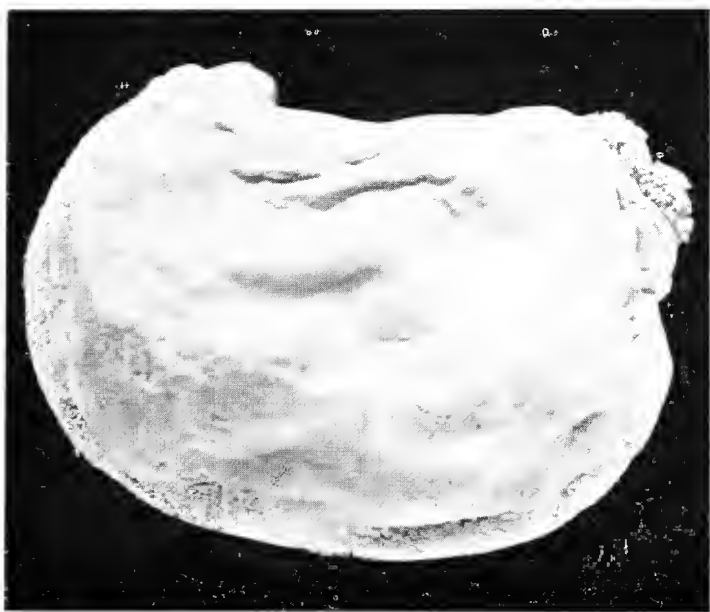
*Peronella aphnostina.*

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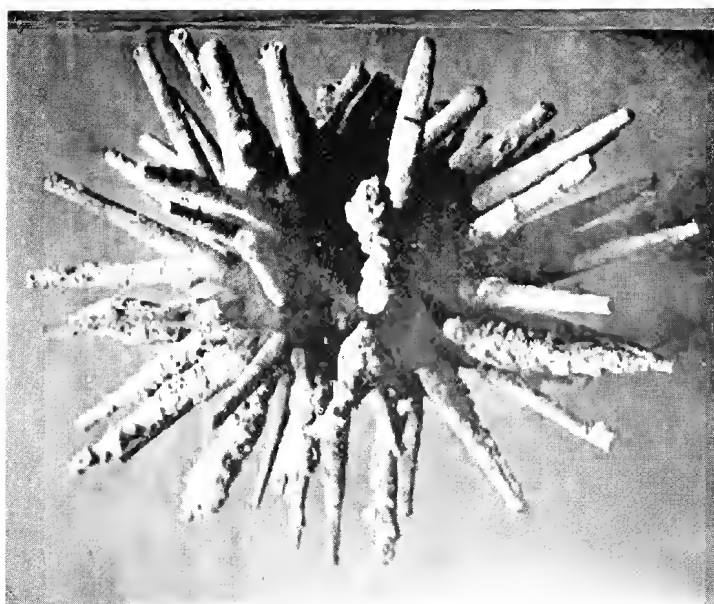
*Conocladus microconus.*



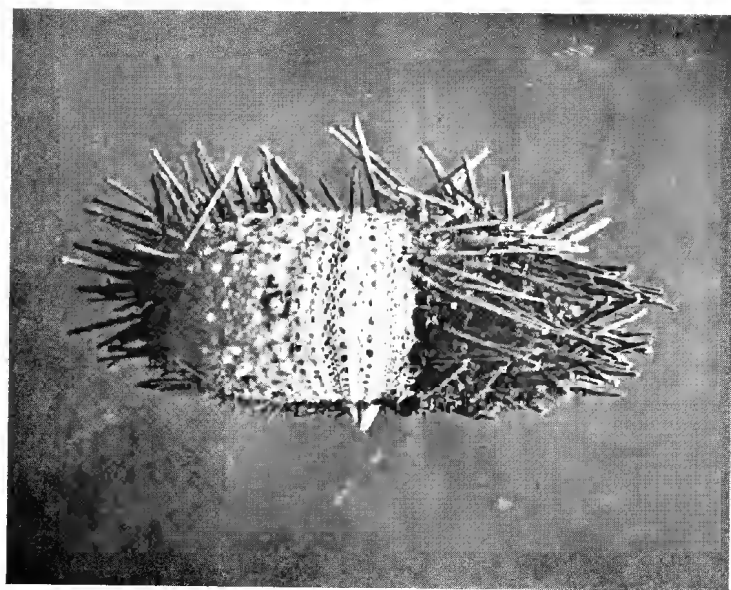
*Colochirus axiologus.*





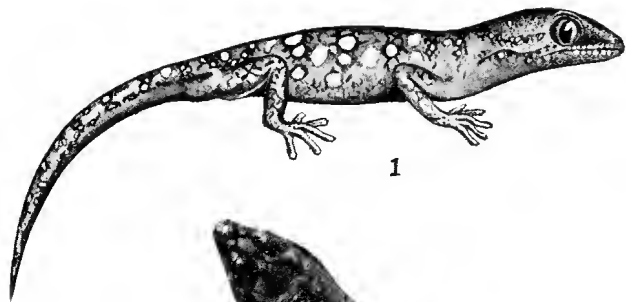


*Phyllacanthus magnificus.*



*Centrostephanus tenuispinus.*





1



2



3



4

D. B. Fry, del]

PLATE XXVII.

[H. Barnes, photo

- FIG. 1—*Diplodactylus woodwardi*, sp. nov. Twice natural size (from type).  
 FIG. 2—*Egernia formosa*, sp. nov. About natural size.  
 FIG. 3—*Lygosoma (Rhodona) picturatum*, sp. nov. About natural size.  
 FIG. 4—*Demansia affinis*, Günther. Natural size.





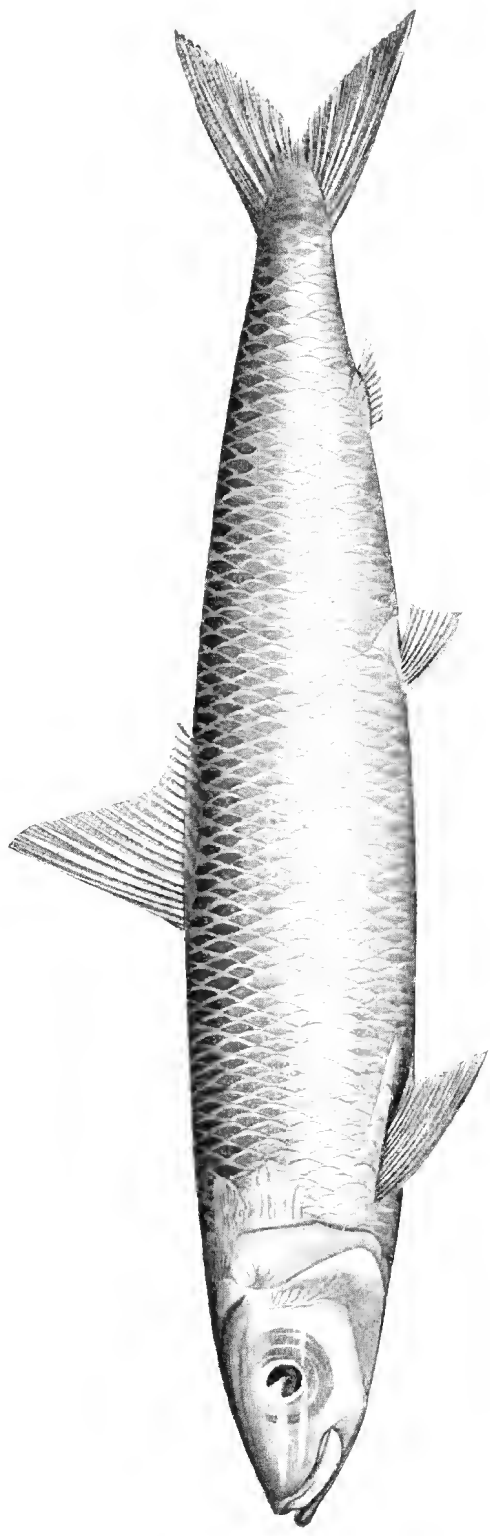
D. B. Fry, del.]

PLATE XXVIII.

FIG. 1.—*Crinia georgiana*, Gray, var. *stolidata*, Cope. Twice natural size.

FIG. 2 and 2 a.—*Crinia leui*, Fletcher. Twice natural size.

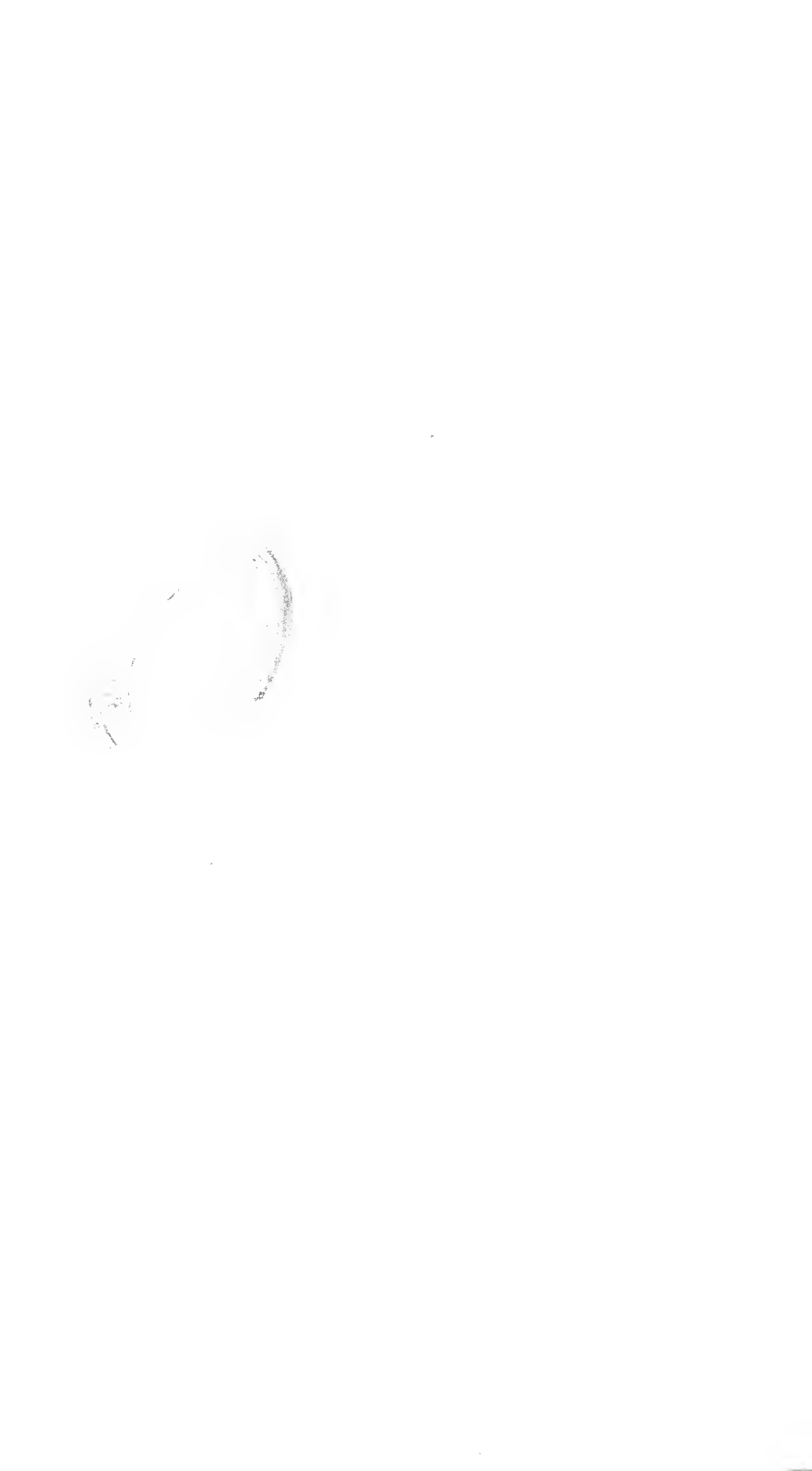




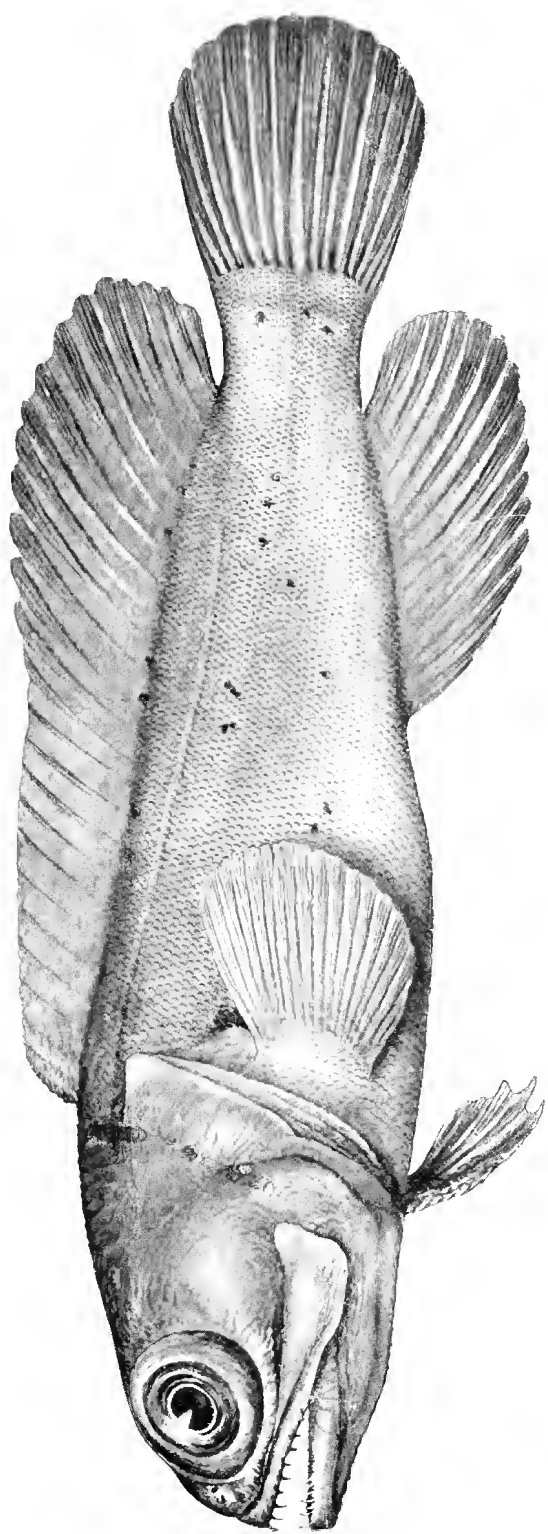
A. R. McCulloch. del.]

*Etrumeus jacksoniensis*, Macleay.

PLATE XXIX.



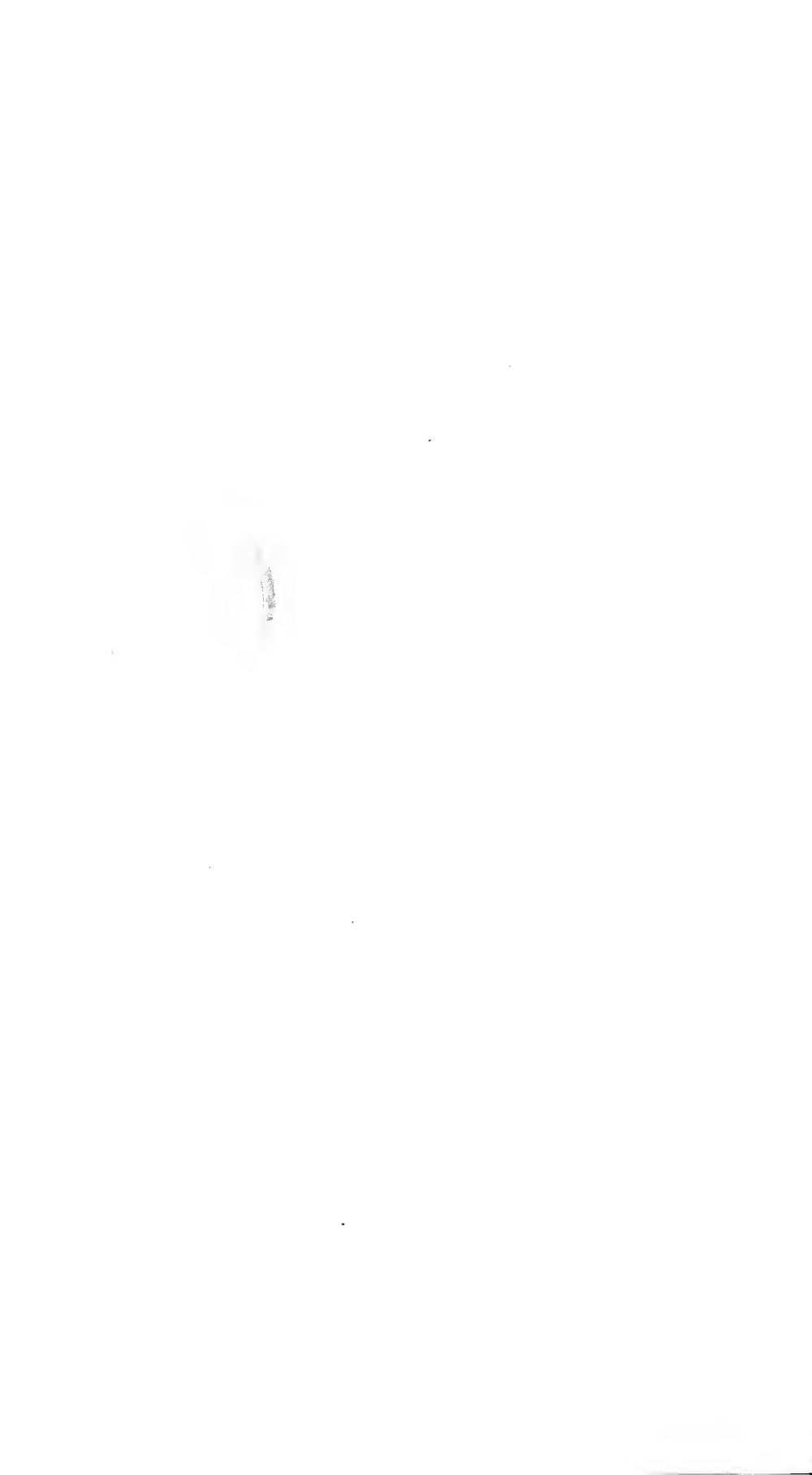


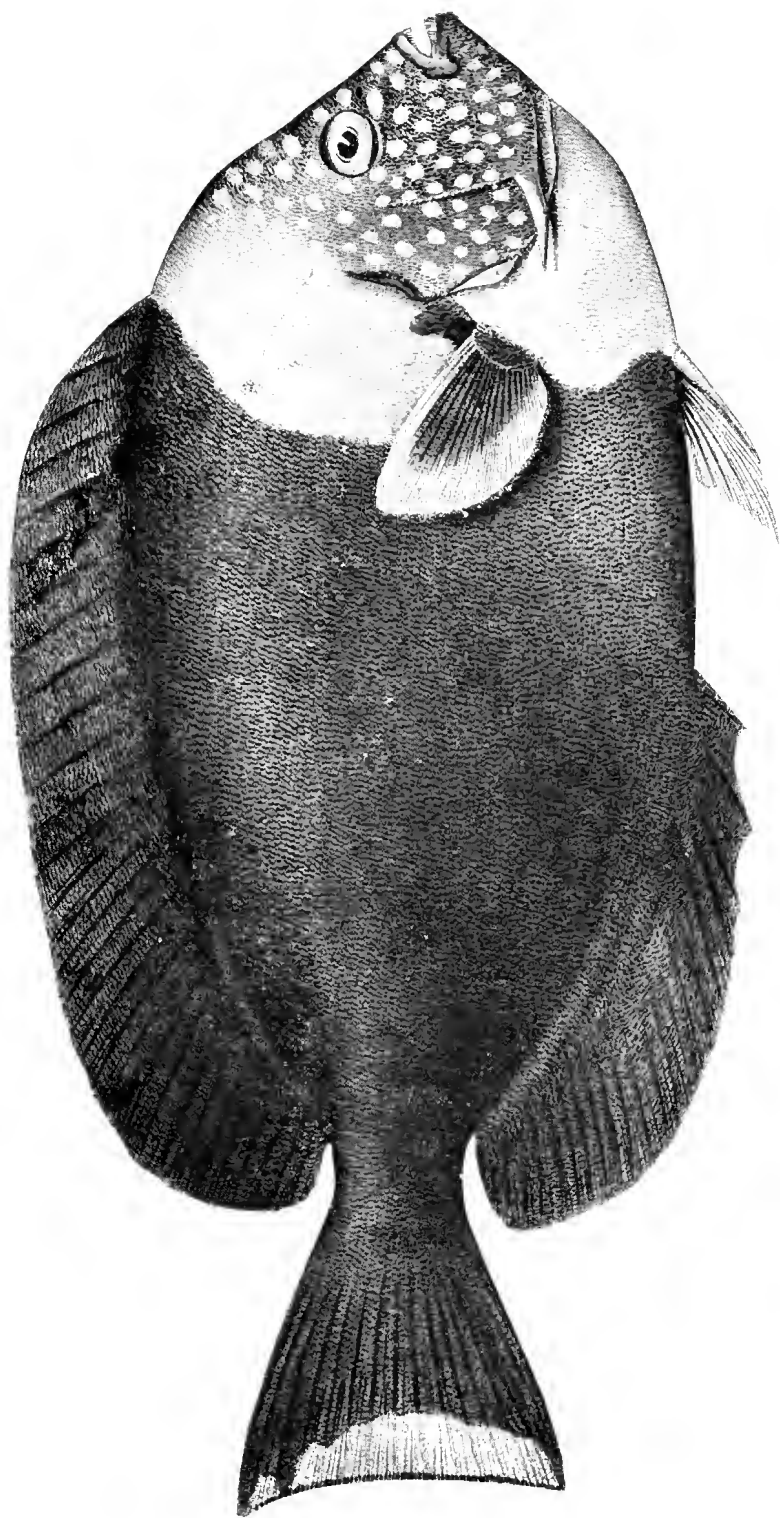


A. R. McCulloch, del.]

*Gnathypops inornatus*, Ramsay and Ogilby.

PLATE XXX



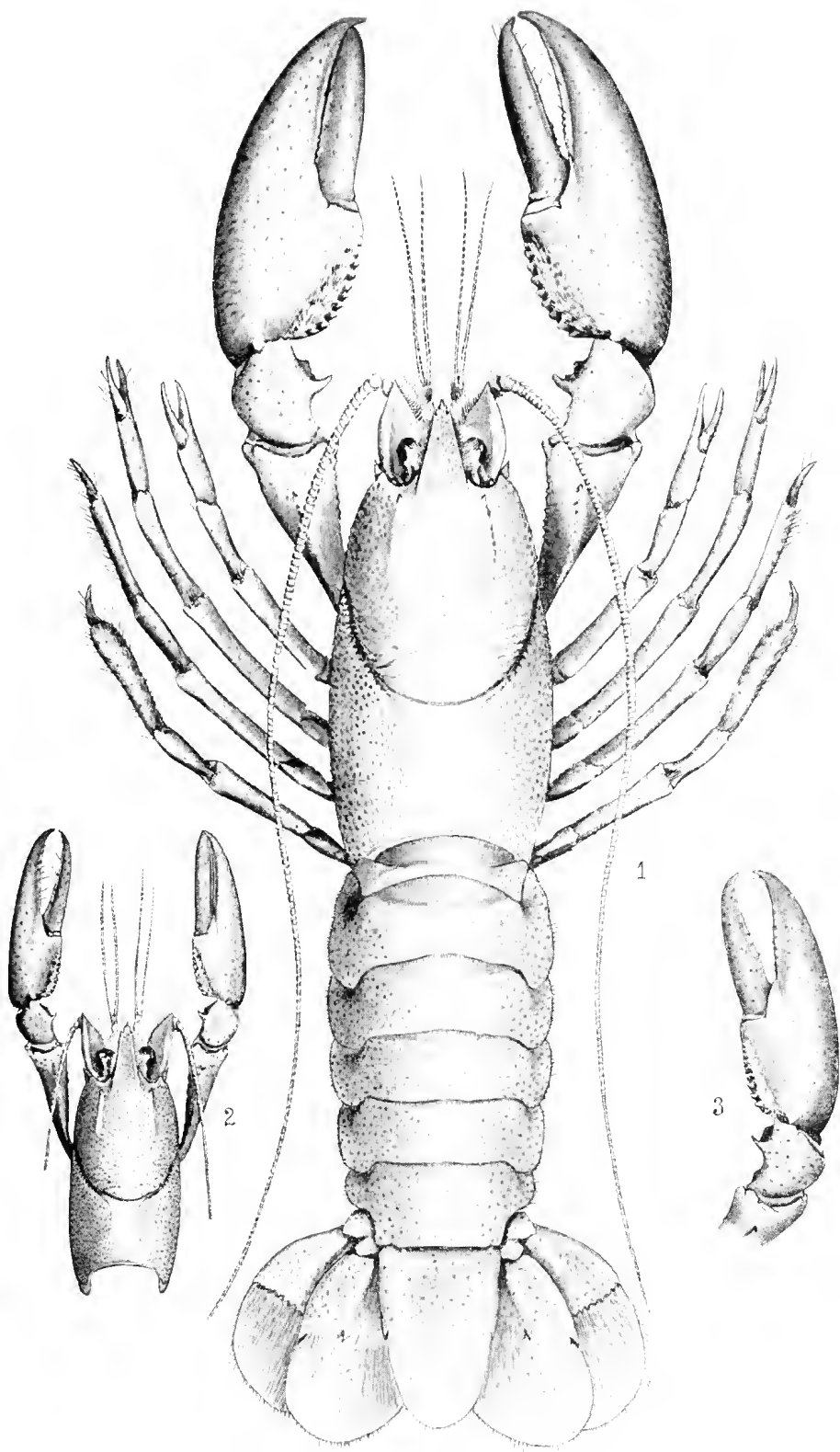


*Holacanthus personifer*, McCulloch.

PLATE XXXI

A. R. McCulloch, del.

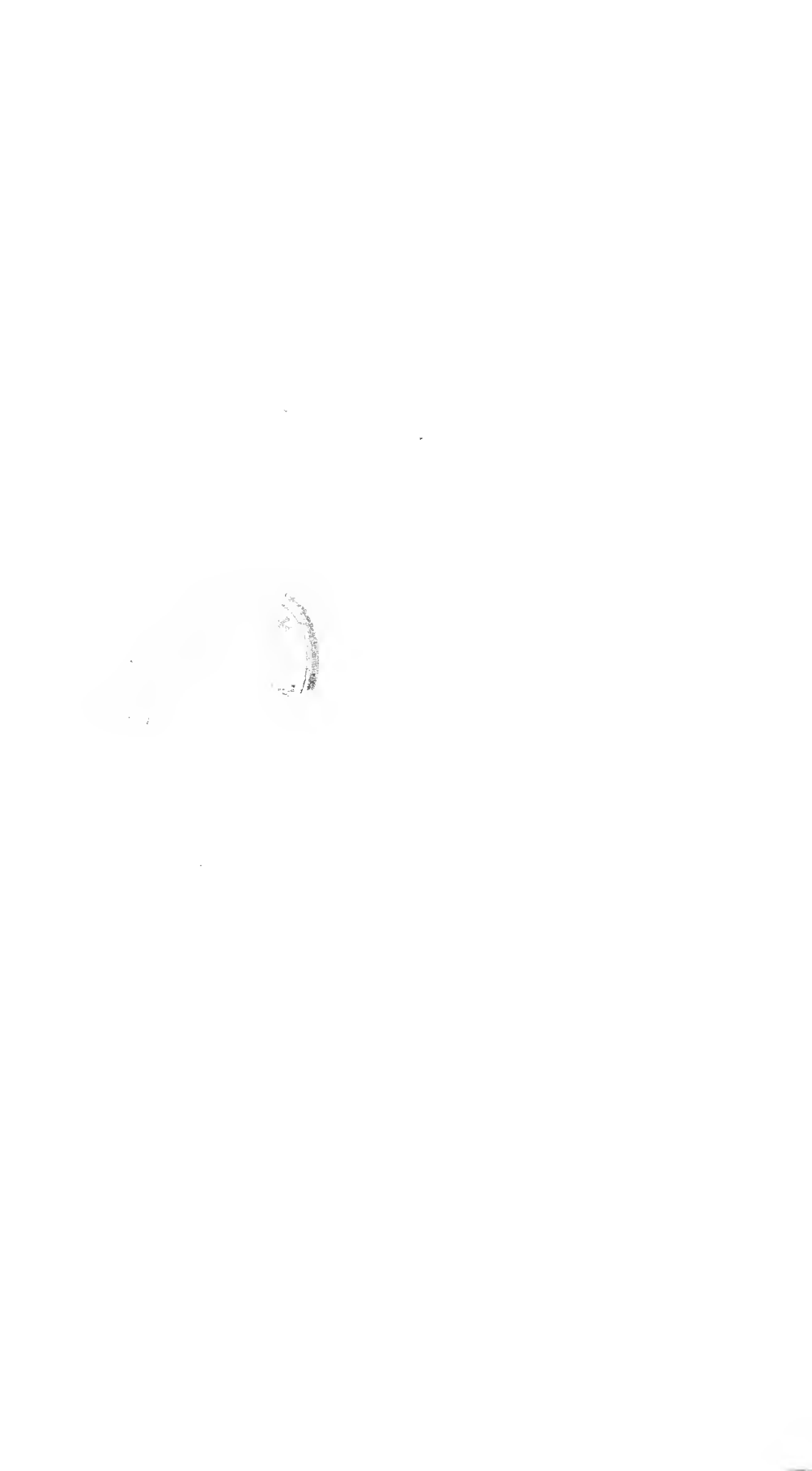
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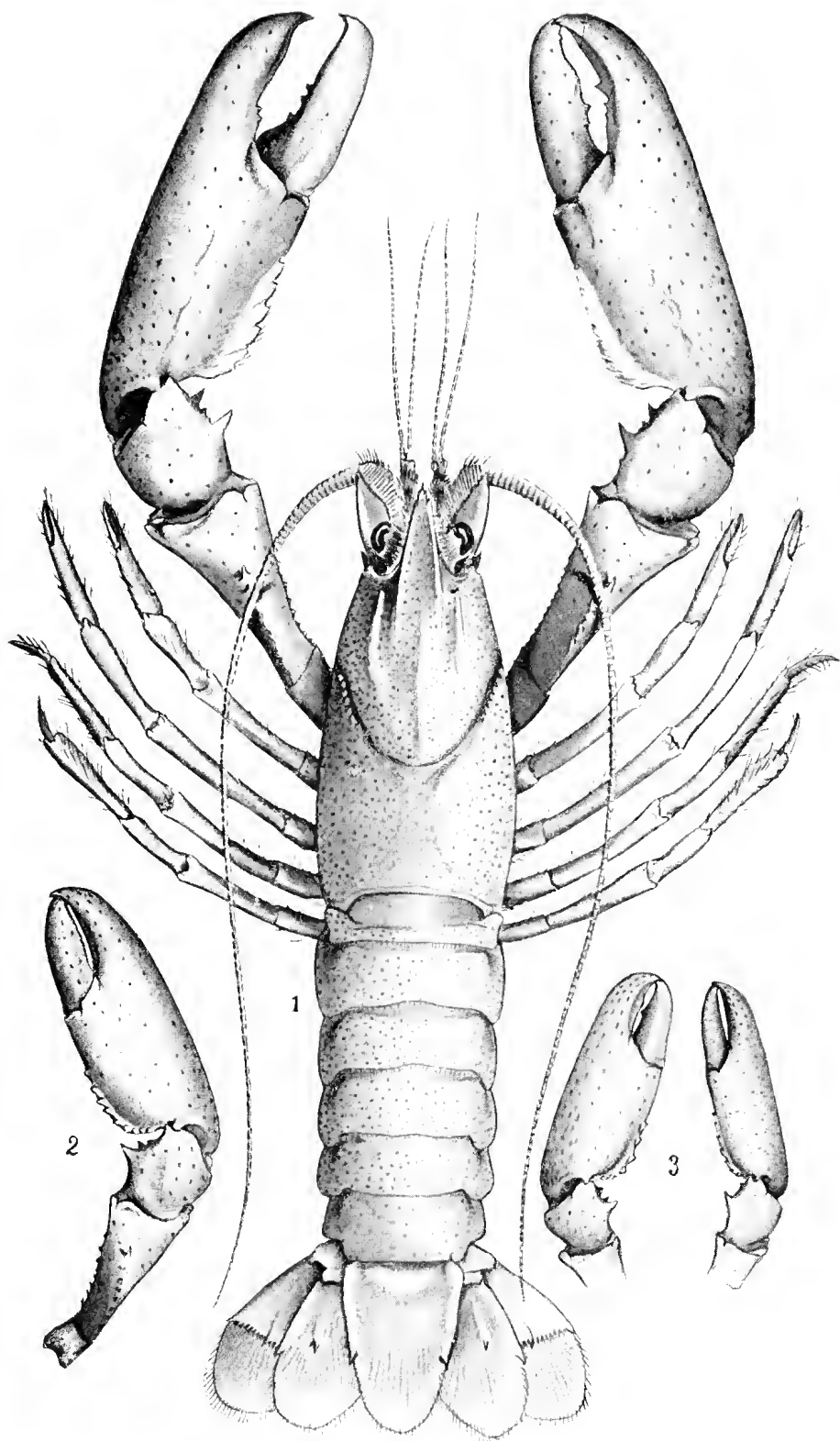


A. R. McCulloch, del.]

*Cheraps preissii*, var. *angustus*.

PLATE XXXII.





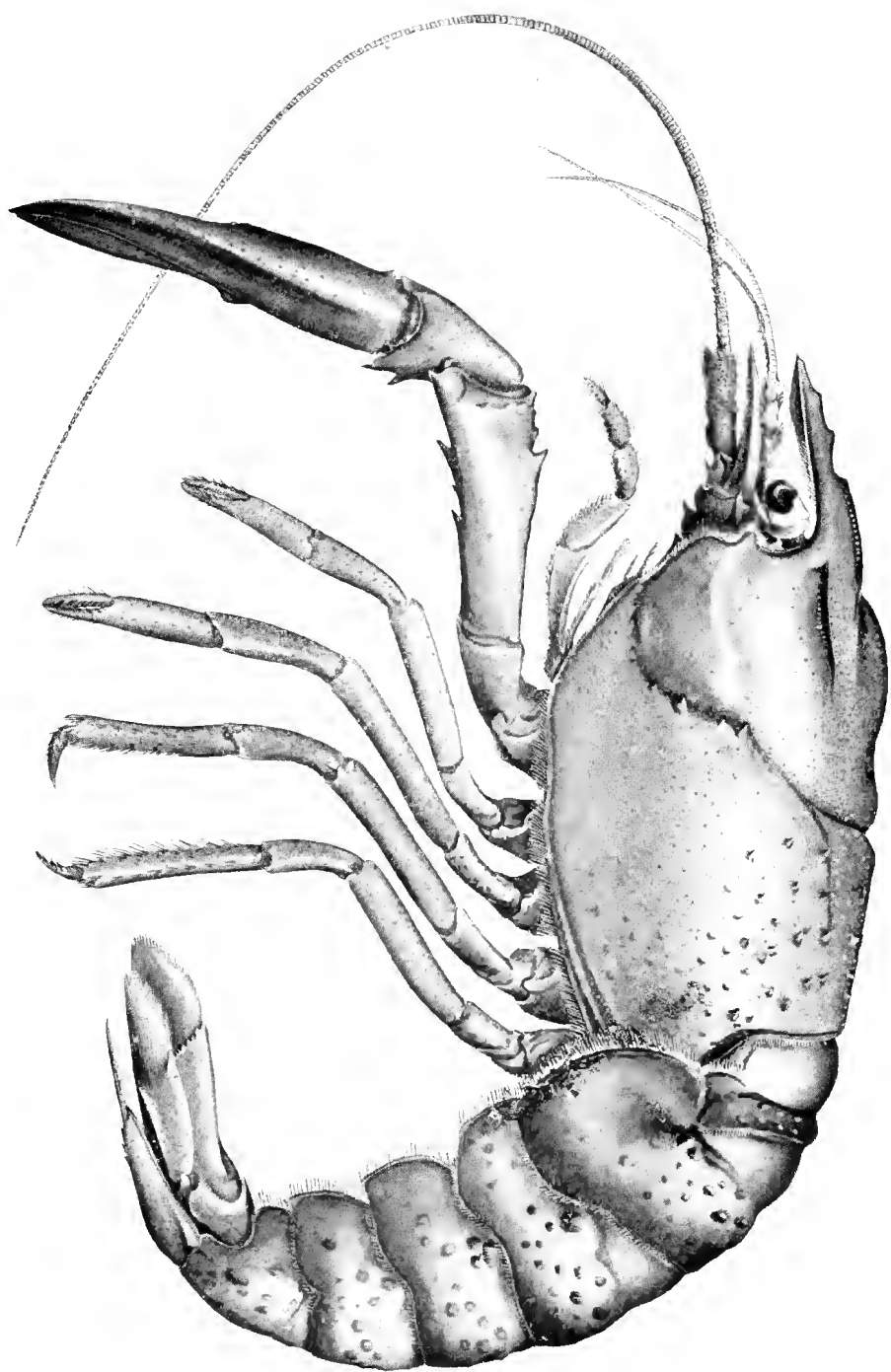
A. R. McCulloch, del.]

*Cheraps quinquecarinatus.*

PLATE XXXIII.





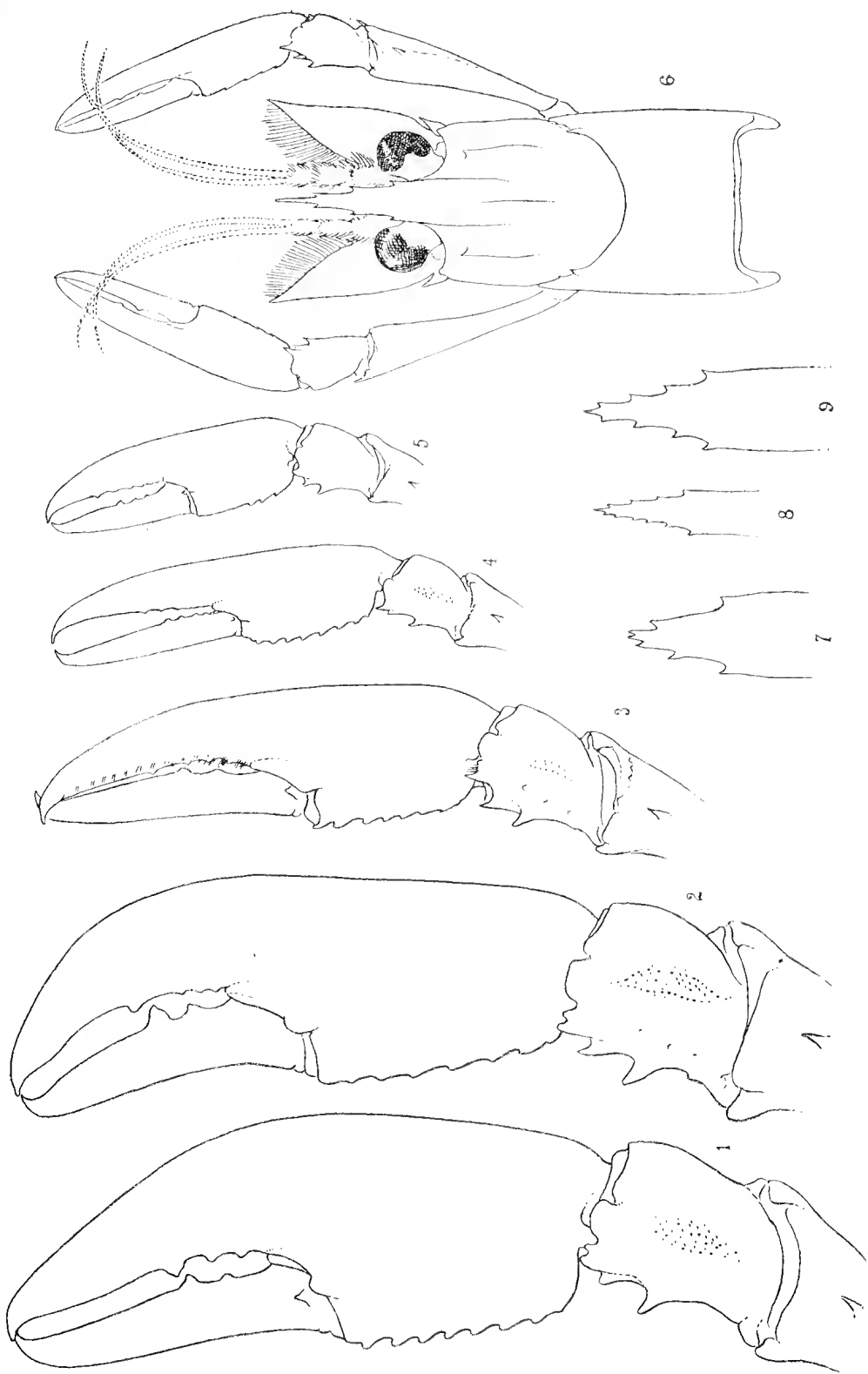


A. R. McCulloch, del.]

*Cheraps tenuimanus*, Smith.

PLATE XXXIV.



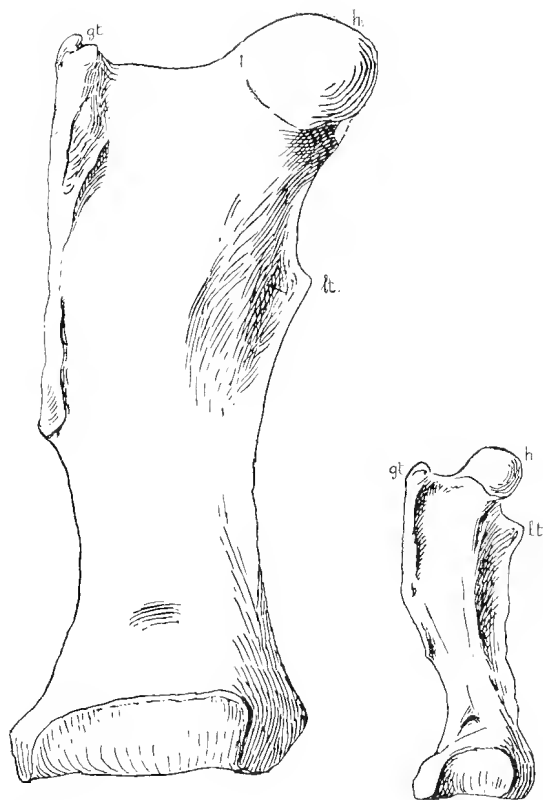


A. R. McCulloch, del.]

*Cheraps tenuimanus*, Smith.

PLATE XXXV.





G. P. Morison, del.]

Fig. 1. *Zaglossus hacketti*, sp. nov., right femur, anterior aspect.

Fig. 2. *Tachyglossus aculeatus ineptus*, Thos., right femur, anterior aspect.

#### LETTER REFERENCES

h. Head of the femur. gt. Great trochanter. lt. Lesser trochanter.

Scale—Three-quarter natural size.

PLATE XXXVI.



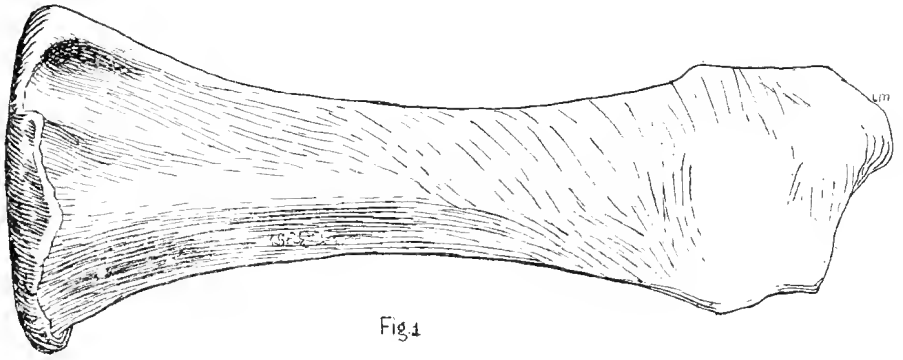


Fig. 1



Fig. 2

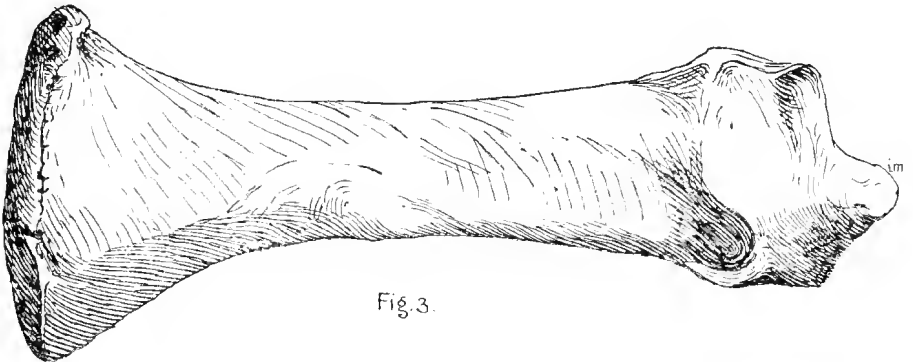


Fig. 3.

G. P. Morison, del.]

*Zaglossus hacketti*, sp. nov.

Fig. 1. Right tibia, anterior aspect.

Fig. 2. Right tibia, internal aspect.

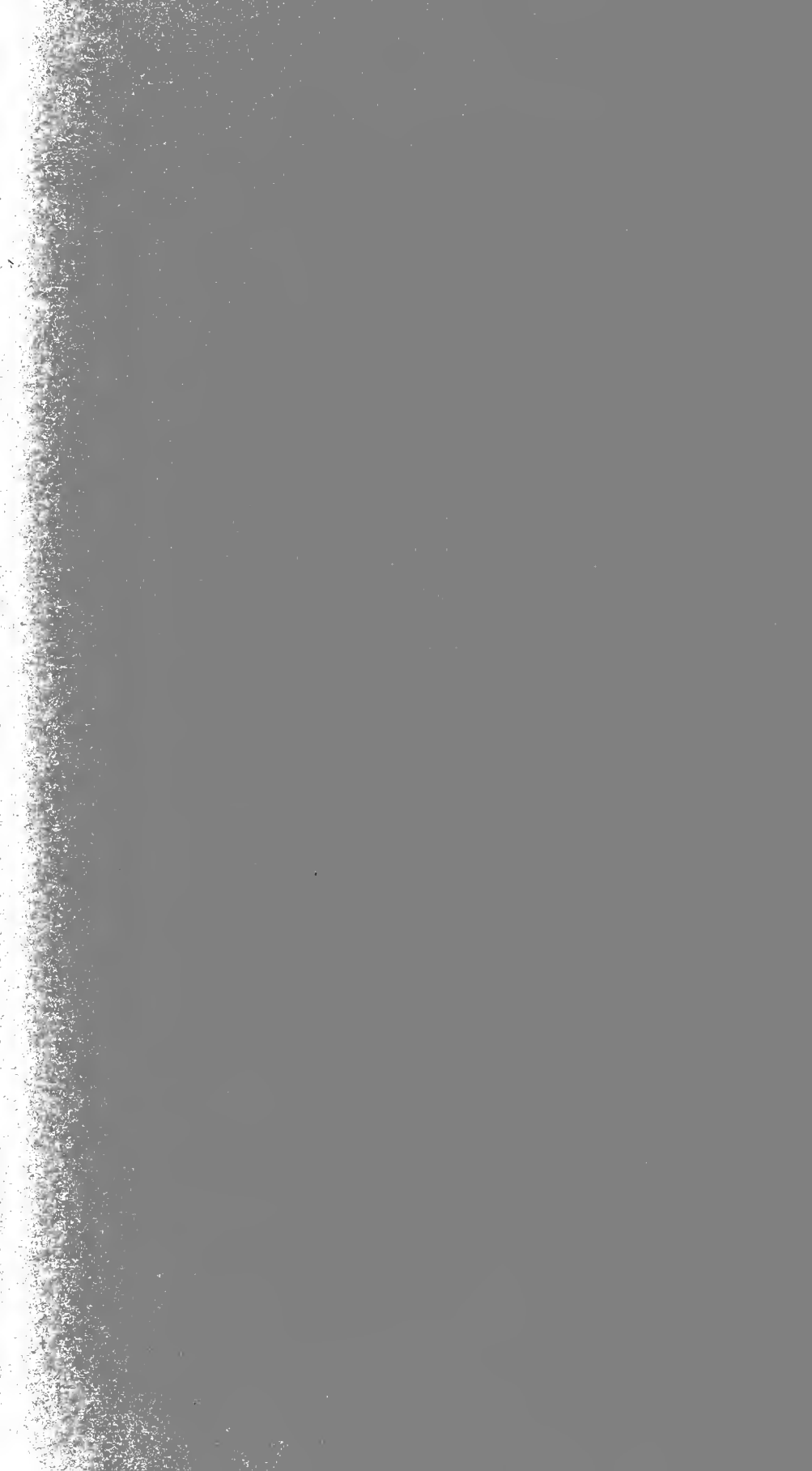
Fig. 3. Right tibia, posterior aspect.

Letter Reference—i.m. Internal malleolus.

Scale—Natural size.









*complete  
no more published*

RECORDS  
OF THE  
WESTERN AUSTRALIAN  
MUSEUM AND ART GALLERY

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VOLUME II.  
PART I.

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A Review of the Land  
Mollusca of Western Australia  
by Tom Iredale.

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# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM AND ART GALLERY.

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VOLUME II.

PART I.

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## A REVIEW OF THE LAND MOLLUSCA OF WESTERN AUSTRALIA.\*

By TOM IREDALE,

Conchologist, The Australian Museum, Sydney, New South Wales.

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*By Permission of the Trustees of the Australian Museum.*

Forty odd years ago E. A. Smith of the British Museum published an account of the land shells of Western Australia, and since then numerous additions are available for record, and the present essay brings our statistical knowledge down to date. Twenty years ago Hedley listed the species, then known, in his Preliminary Index but no detailed revision was attempted. It must be emphasised that this review is intended to serve as a basis for Western Australian workers, and consequently most attention has been paid to the taxonomy and discrimination of the named forms. It is important in this group to know the topography, geography, geology and botany, a combination I have termed Geozoology, of the State to define exactly the status of the molluses collected, all these factors being of definite influence in the evolution of the mollusc. It may be pointed out that in over one hundred years of history of the State no local naturalist has made any major contribution to our knowledge of this group though probably no more profitable group could be selected, the problems being innumerable and all of them interesting. Smith noted "The report is limited to those species occurring west of long. 129°E., the boundary line between West Australia and South Australian territory. Its extreme length from north to south is 1,250 miles and 800 from east to west, and it embraces an area of 1,000,000 square miles." The limits given are those of Western Australia, as politically known, but the area does not agree with that provided by the W.A. Government, which in the Year Book before me reads 975,920 square miles. I have indicated the natural divisions of Australia as shown by the Land Mollusca, and it will be seen from the map here reproduced that within the unnatural political boundaries of Western Australia three faunulae are represented, two restricted and one intrusive element. The Antiochthonian Faunula restricted to the south-west corner, termed the Leenwinian Area, is characterised by the very peculiar Bothriembryontid development. With it are a few Endodontids, the only Helicarionid west of Victoria, and a (perhaps) Rhytidid, no Helicids save through intrusion. On the other hand the north-west part of Australia, called the Dampierian Sub-Area, is inhabited by a Caurine Faunula which is of very peculiar facies related to the molluscan fauna of

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\* This paper was published by the Royal Society of Western Australia in Volume XXV. of its Journal.

the East Indies rather than with that of the adjacent territories. These are peculiar Helicids, and no Bothriembryontids occur save as stragglers into the southern point. There is no *Helicarion* and no Rhytidid while the so-called Chloritids are peculiar, and two Microcystids occur. These two faunulae are very peculiar in their composition, and the third is that of the Centralian Area, known as the Eremian or Eyrean Faunula, an intrusive series. This faunula ranges across the whole of the centre of Australia and runs into the south-west, meeting members of the Autochthonian Faunula. It further reaches the coast to the north of the Leenwinian Area, but so far it has not been recognised in connection with the Caurine Faunula. This inland area of Western Australia has not been explored for molluses so that probably many species exist. While these may be related to the known members of the Eremian Faunula it is possible that the novelties may offer shells of different form.

Possibly the vegetation will offer most assistance and in this respect "The Soils of Australia in relation to Vegetation and Climate" (Commonwealth C.S.I.R. Bulletin No. 52, 1931) by Prescott is worthy of intensive study. Examination of the vegetation map therein included suggests that the groups of Bothriembryontid molluses are distributed in accordance with the botanical data.

The following account as to the rainfall, the most important item in the life history of a snail, is taken from an official source. The rainfall varies throughout the South-West division, ranging from an annual average of 50 inches in the heavily timbered portions of the coastal districts to 18 inches at Geraldton and nearly 10 inches at Yalgoo, from 36 inches at Albany to 14 inches at Israelite Bay, and from 44 inches in the Darling Ranges to 21 at Toodyay, 16 at Northam, and 10 at Southern Cross. A similar diminution occurs eastward of Bunbury, starting with a register of 37 inches. The climatic conditions are vastly different in the tropical parts of Western Australia. Heavy tropical rains fall from the end of November to the end of March, with rarely a wet day during the rest of the year. For instance the average at Wyndham is nearly 27 inches of which  $24\frac{1}{2}$  fall in November to March, another  $11\frac{1}{2}$  in October and April, the total from May to September inclusive being less than 1 inch. On the other hand that of Perth is only 34 inches, December, January, February averaging nearly  $\frac{1}{2}$ -inch each month, April and May nearly 1 inch each while May, June, July and August have from 5 to 7 inches each month. The rainfall at Albany is a little lighter in the winter months, but a little heavier in the summer, totalling a little more than 39 inches in the year. In this connection it may be recorded that apparently most Western Australian snails develop a strong epiphragm for use during the long dry spells.

I have long hoped to provide a ground work for students of Australian land-shells as these are very abundant, varied in form and scientifically very valuable. To this end I have published A Basic List of the Land Mollusca of Australia in the Australian Zoologist (Vol. VIII., pp. 287-334, Mch 12, 1937; Vol. IX., pp. 1-39, pls. I-III., Nov. 12, 1937; and Vol. IX., pp. 83-124, pls. XII-XIII., Nov 30, 1938). I later prepared "An Annotated Check List of the Land Shells of South and Central Australia" which has appeared in the South Australian Naturalist (Vol. XVIII., pp. 6-57, pls. I-II., September 30, 1937). The present essay leaves Queensland and New South Wales to be as completely treated, and these I have in hand now. No section, however, provides the delightful complications present in the Western Australian

Fauna and I have to thank sincerely Mr. L. Glauert for the opportunity of examining so much material.

My thanks are also here tendered to my colleagues, Miss Joyce Allan, who has prepared the excellent drawings which accompany this report, and Mr. G. C. Clutton for the photographs of the Bothriembryontid forms.

### I.—HISTORICAL ACCOUNT.

While it be possible that some of the earlier visitors such as Vlaming, Pelsart, Dampier or Vanconver may have carried back landshells to Europe, the first real note was made by Peron in 1807 who recorded that on June 29, 1801, at Bernier Island, also Dorre and Dirk Hartog's Islands, in Shark Bay, "Two species of landshells extremely numerous, but all dead, occupied great stretches of the interior of the island, one was a small species of *Helix*, the other belonged to the genus *Bulimus* of M. de Lamarek."

Thus from this source Ferrussac included in his *Prodrome* *Helix costulata*, *H. melones* and *H. torulus*. The former was not described and figured but localised as "Le port du Roi George, Péron: la baie des Chiens-Marins, Gaudicho," the second as "La Nouvelle-Hollande," the last as "La Nouv.-Hollande, voyage de Péron." It will be noted that another collector Gaudicho (Gaudichaud) is here mentioned. C. Gaudichaud was apothecary on the *Uranie*, on which vessel Quoy and Gaimard were the naturalists: this vessel visited Shark Bay September 12-27, 1818, and was shipwrecked at the Falkland Islands on its way home and the collections made lost: but apparently Gaudichaud managed to save some of his treasures. Lamarek published with a description in 1822 *Bulimus inflatus* citing as synonymous Ferrussac's *H. costulata*. Another species named and figured by Ferrussac, *Helix prunum*, and whose locality was given as "Les Terres Australes, voyage de Péron" has been credited to Western Australia, but examination of the figure suggests an Eastern Australian form. Then the English explorer Captain P. P. King, who was very interested in natural history, collected land-shells at King George's Sound on January 20, 1818. Gray, of the British Museum, described a species naming it after King in 1825, King's own account not being published until 1826. In the latter year the "Astrolabe" another French exploring vessel, was in Western Australian waters, and the brilliant and enthusiastic naturalists Quoy and Gaimard were on board, intent to make up for their losses in the *Uranie* shipwreck. The land-shells secured were this time safely taken to Paris and were carefully described and beautifully illustrated in one of the most splendid works on natural history yet issued.

An unknown collector, probably Robert Brown, provided Gray of the British Museum with some material, and it has only recently been recognised as coming from the Recherche Group. A little later a German collector, Dr. L. Preiss, visited South-West Australia in 1839-40, and Menke issued an account of the mollusca in 1843. At the same time Gilbert, the famous ornithological assistant of Gould, secured some shells and these were transferred to the British Museum by Gould, and have been regarded as having been collected by that gentleman, who, however, never reached Western Australia during his famous travels. Simultaneously Captain Stokes was exploring the West Coast and he and his men were notable collectors, Dring, Wickham and Ince all coming under notice in connection with land-shells. Unfortunately the exact localities were not preserved by those to whom the shells passed and thus in some cases it has been a matter of great difficulty in determining these at the present time. It must be remembered that this was the day of sailing vessels which called in and sheltered at places not now commonly resorted

to, but when intensive collecting is carried out it may become easy to fix the exact place as the species are comparatively well defined.

When Eyre crossed from South to West Australia he noted shells scattered about on the ground but that does not concern us as none appears to have been collected. It must be recalled that he was succoured by Captain Rossiter of the French whaler *Mississippi* on June 2, 1841. That particular captain happened to be a very zealous amateur conchologist, and later settled in Sydney, when the well-known professional conchologist John Brazier married his sister. Later Brazier circulated shells collected by his brother-in-law, who had secured them on the islands of the Recherche Archipelago when whaling about them.

Until this date all the species had been described in Europe, and a few collected by Dr. Bacon in the Swan River Settlement were named by Benson, but now Australian conchologists became qualified, and Cox, Hedley, Angas, Brazier, Tate and Hedley have all made additions to our knowledge. Still the spell of the extralimital worker held, although he was ignorant of local conditions and heedless of geography and history. Thus E. A. Smith in the *Zoology of the Voyage of the Erebus and Terror* dealt with two plates (that had been prepared for Stokes) under the impression that they had something to do with that voyage. Fortunately the species figured were so distinct that he could not make many mistakes, but he managed to confuse matters a little. Smith, however, assisted our study, when he prepared the first complete account of Western Australian land-shells based upon a collection made by the well-known entomologist, J. J. Walker,\* when he was chief engineer on H.M.S. *Penguin*, surveying off the North-West coast of Australia. It is unfortunate for Australian students that Walker's collection was made on almost inaccessible islands, but his discoveries opened a new vista for the forms were of novel facies and now provide the most intriguing problem in our science.

W. W. Froggatt, a professional entomological collector, went to Derby and explored the Napier and Oscar Ranges, and brought back some twenty species of land and fresh-water molluscs. Some of these were described by Cox and others by the great French conchologist Ancy, but no complete study of the collection was attempted. The bulk went into the Macleay Museum and has been here utilised. Years later Dr. Herbert Basedow went into the Napier Ranges, and an excellent collection was briefly recorded by Hedley. The dominant Western Australian group, *Bothriembryon*, was carefully monographed by Pilsbry, who had much material sent him for the purpose by Cox, but the localities provided by the latter were untrustworthy and misleading. Kobelt, a year later, also catalogued the group, practically following Pilsbry. Some odd species have been named by Fulton, Preston, Gude, Odumer and Thiele. The two latter dealt with collections made by Swedish expeditions to the North-West, and German expeditions to the South-West, respectively.

Mr. Sidney W. Jackson visited Western Australia in 1912, and working in the Bow River district, south coast, made a fine collection which was accompanied by excellent field notes. This series included many novelties and was examined by Hedley but the results were never published. About ten species were secured, all of them new, and suggest great possibilities to some local enthusiast.

The only recent collectors have been Mr. L. Glauert, the Director of the Museum, to whom I am greatly indebted for the opportunity of studying the material in that Museum, upon which this review is primarily based; Mr. F. R. Bradshaw, of Tambellup, and Mr. E. Sedgwick, of Nangeenan, each of whom have sent me very interesting shells.

\* Died February, 1939.



It is my great hope that this account will arouse someone in Western Australia to study their own molluscan fauna, which suggests more problems than almost any other in the world. Prior to Smith in 1894 some thirty-five species had been recorded: in his essay Smith added eighteen, that is half as many again. Hedley listed the fauna in 1915 as eighty, that is almost exactly half as many again. This list has increased the number in a similar proportion, and yet I conclude that the number on record is only a small proportion of the molluscs living. A representative collection will be made available at the Perth Museum for students, and I will be only too pleased to assist any such in any way that I possibly can.

## PHYLUM MOLLUSCA.

### Class GASTROPODA.

### Subclass PROSOBRANCHIA.

### Order PECTINIBRANCHIA.

### FAMILY HELICINIDAE.

Small conical operculates, solid, spire short, whorls flattened, periphery subkeeled, umbilical area covered by a callus pad.

Genus **PLEUROPOMA** Möllendorff 1893.

- 1893—*Pleuropoma* Möllendorff, Ber. Senckenb. Nat. Ges. Frankfurt, 1893, p. 140, July. Orthotype *Helicina dichroa* Möllendorff.
- 1905—*Aphanoconia* Wagner, Denksch. K. Akad. Wissen. Wien, Math. Nat. Class., Vol. LXXVII., p. 388. Logotype Fredale, Austr. Zool., Vol. VIII., p. 291, 1937, *Helicina rerecunda* Gould.
- 1905—*Reticulata*, *Sculpta*, *Dichroa* id. ib., sectional names only with Tautotypes.
- 1909—*Albocincta* Wagner, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. 18, heft cccxxv., lief 535, p. 169. Tautotype *Helicina albocincta* Hombron & Jacquinot.
- 1909—*Sphaeroconia* id. ib., heft cccxxviii., lief 538, p. 189. Logotype Fredale, Austr. Zool., Vol. VIII., p. 292, 1937, *Helicina sphaeroconus* Möllendorff.

***Pleuropoma walkeri* Smith 1894.**

Plate I., fig. I.

- 1894—*Helicina walkeri* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 99, pl. VII., fig. 26, June. Queen's, Baudin and Parry Islands, North-West Australia.
- 1909—*Aphanoconia* (*Sphaeroconia*) *bandinensis* Wagner, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XVIII., p. 217, pl. 43, figs. 11-13, as of Smith *errore*, new name for *walkeri* Smith. Baudin Island, N.W.A.

Shell small, depressedly conical, spire short, whorls flattened, last whorl subkeeled, mouth lunate, outer lip slightly thickened, umbilical area covered by a callus which extends across to outer lip. Coloration fawnish with a whitish peripheral band, and sometimes a paler base, some shells unicolor fawn. Apical whorl smooth, adult whorls three and one half, dull, with faint growth striae but no spiral striation. The umbilical pad is

roughened, the columella short, straight, the operculum thick, horny. The specimens before me from Baudin Island, presented by the collector J. J. Walker, are apparently slightly smaller than the type measured by Smith, who gives "Diam. maj. 5, alt. 3.5 mm.": these are about 4 mm. in breadth by 3 mm. in height.

#### FAMILY CYCLOPHORIDAE.

This family does *not* occur in Western Australia, though two species were described by Benson as having been collected at the Swan River by Dr. Bacon. As this collector also worked in India it is apparent that the localities became confused, and the Cyclophorids described originated in India. The names were *Cyclostoma liricinctum* and *C. orbiculatum* Benson, Ann. Mag. Nat. Hist., Ser. II., Vol. XI., p. 106, February, and they were figured by Reeve, Conch. Icon. Vol. XIII., *Cyclophorus*, Vol. XX., sp. 100 and 101, Aug. 1861. They can now be completely dismissed from this fauna.

#### Subclass PULMONATA.

This subclass includes all the land snails save those with an operculum, and as only one of the latter comes into our review, the remaining members of our fauna here follow. Numerous smaller divisions are utilised in classifying this large number.

#### Order STYLOMMATOPHORA.

The subclass is separated into two Orders, but only one is represented in this fauna, but this has been subdivided into many large groups, but as they seem somewhat artificial, only the families are here mentioned.

#### FAMILY VERTIGINIDAE.

This family name was previously used for all Australian pupoid shells, but as now restricted, no representative is yet known from Western Australia, but as the species are very small and difficult to find and so little searching has yet been done in this land it cannot be definitely stated that the family is absolutely absent from the State.

#### FAMILY GASTROCOPTIDAE.

The minute Pupoid shells of Australia were placed in one family in the Basic List, following Pilsbry's Monograph, but upon reconsidering the species in connection with the South Australian forms I regretted that action. I merely noted my objection in my account, but here allocate the Western Australian shells in a more scientific manner. It became quite obvious that we were dealing with diverse stocks, and then it was seen that Pilsbry himself had been dubious of his own action. Steenberg, a European authority, has given an excellent account of the anatomy of these difficult minutiae, and separated the Palaearctic forms into many families. Following this worker, the Australian species would be arranged in four families, and this is much nearer the truth. The few Western Australian species then fall into three families:

Shell very small, pupoid, with small mouth with complex armature;  
species dextral or sinistral.

Gastrocoptidae.

Shell small, but larger than preceding, with no armature in mouth save  
a tubercle or base of shell adjacent to outer lip.

Pupoididae.

Shell very small, stouter than first named, mouth armature not so complex and folds differently placed.

Pupillidae.

Genus **AUSTRALBINULA** Pilsbry 1916.

1916—*Australbinula* Pilsbry, Man. Conch. (Tryon), 2nd Ser., Vol. XXIV. (pt. 93), p. 11., Dec. 18; id. (pt. 94) pp. 155/166, July 18, 1917. Orthotype *Gastrocopta hedleyi* Pilsbry.

Small Pupoid shells, dextral, rarely sinistral, faintly striate, with the small mouth almost closed by teeth blocking the aperture: a large columellar tooth; on the base of the shell one to three, called the parietal teeth, one of which is generally larger than the others; and on the inside of the outer lip three or four, called palatal teeth. All the shells are small, up to 3 mm. in length, and must be examined microscopically for differentiation.

***Australbinula wallabyensis* Smith 1894.**

1894—*Pupa wallabyensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 97, June. East Wallaby Island, Houtman's Abrolhos (Walker).

1916—*Bifidaria wallabyensis* Hedley, Journ. Roy. Soc. West. Aust., Vol. I., p. 217 (68 in sep.).

1917—*Gastrocopta wallabyensis* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXIV., pt. 94, p. 171, July 18.

Unfortunately this species has not yet been figured, and no specimens from the Abrolhos are available. Smith described it in great detail as follows: "Shell dextral, cylindrical, pellucid, white, narrowly rimate; whorls five, very convex, sutures profoundly impressed, very obliquely striate, the last whorl ascending at the aperture; spire cylindrical, obtuse to the apex; aperture very small, ringent, one fourth the total length of the shell, furnished with seven unequal teeth (three very small parietals, the middle one largest, one large columellar lamelliform tooth, three large lamelliform palatals); peristome lightly expanded, margins approaching, joined by a thin callus. Length 2.5, diameter 1 mm. *Hab.*, East Wallaby Island, Houtman's Abrolhos (Walker). The teeth of this species are very characteristic, and block up the aperture to a considerable extent. The three parietal are much smaller than the rest, and situated close together, the central one being the largest. That on the columella is large, lamelliform, and prominent. The central palatal tooth is narrow, long, and extends inwards; those on each side of it are shorter, but a trifle more prominent perhaps. *P. Macdonneli*, Brazier, from Fitzroy Island, N.E. Australia, is a little shorter than this species and has more feeble armature in the aperture." Pilsbry added: "Mr. B. B. Woodward, who has kindly examined the type specimen for me, states that the columellar lamella ascends within. The species is therefore related to the polymorphic *G. larapinta*. It differs by the unusually small aperture (only one-fourth the total length, while in *larapinta* it is at least one-third), and the narrower contour of the shell."

***Australbinula complexa* sp. nov.**

Plate 1. Fig. 7.

Pilsbry (Man. Conch. (Tryon), Ser. 11., Vol. XXIV. (pt. 94), p. 170, July 18, 1917) proposed *Gastrocopta larapinta deserti* for a form of pupoid shell, picked out of series sent from Central Australia by Professor Tate as

"*mooreana*." Various Centralian localities were confused, and Pilsbry added Forrest River, North-Western Australia, an indiscreet addition. However he figured the specimens so that separation is easy. His first measurement of his "*deserti*" is length 2.25, diameter above aperture 1.15 mm., and that agrees with his figure 3 on plate 2, which is here selected as type. His figure 1 shows a more slender shell also without locality.

Mr. E. Sedgwick has sent from Nangeenan via Merredin shells recalling this figure 1 in form, but with the whorls even less rounded and the tip more obtuse. The angular lamella is more pronounced and there is a notable basal fold present. The type measures 3 mm. in length by 1.25 mm. in breadth.

***Australbinula helmsiana* sp. nov.**

Plate 1. Fig. 2.

1917 *Gastrocopta larapinta deserti* Pilsbry, Man. Conch., (Tryon), Ser. II., Vol. XXIV., p. 171, pl. 30, fig. 1, July 18. Specimens only from Forrest River, North-Western Australia (R. Helms).

At the place quoted Pilsbry recorded that these specimens, one of which he figured was "a little larger, 2.5 to 2.55 mm., long, diameter 1.1 mm., or 2.4. 1.2 mm. There is no brownish tint except what may be caused by the dried animal. There is a small infraparietal nodule in some examples, wanting in others. The columellar lamella has a rounded outline and ascends obliquely inward. Lower parietal plica is strong, the upper smaller and far shorter. There is no basal fold. The lip expands broadly." Shell minute, cylindrical, dextral, whorls round, sutures deep, spire obtuse, sculpture delicate oblique striae, mouth with outer lip expanded, aperture with intrusive teeth as noted above.

***Australbinula mooreana* Smith 1894.**

Plate 1. Fig. 4.

1894—*Pupa mooreana* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 97, pl. VII., fig. 25, June. Roebuck Bay, North-West Australia.

1916—*Bifidaria mooreana* Hedley, Journ. Roy. Soc. West Austr., Vol. I, p. 217, (p. 68 in separate).

1917—*Gastrocopta mooreana* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXIV. (pt. 94), p. 160, pl. 30, fig. 4 (copied from Smith): Vol. XXVI. (pt. 104), p. 230, pl. 24, fig. 6, 7, Nov. 1921: paratypical specimens figured.

"Easily distinguished by the sculpture."

Striae irregular, interrupted by malleation or shallow uneven pitting the parietal lamella is not connected with the angular lamella which is straight, the parietal not very long and only slightly curved. There are only two palatal folds, the lower being larger and almost taking the place of the basal which is missing. The columellar lamella is deeply set and straight. Perhaps nearer *ficulnea* than *Gastrocopta* the angular laminae being present but not connected; this feature may be of value in either connection, hence to indicate this abnormality the new subgeneric name **Westralcopta** is here introduced. Pilsbry's account of paratypes is here added for reference: "The shell resembles *G. larapinta* in contour, but has a special character in the sculpture as seen under the microscope, the striae being made irregular, and in places interrupted by *malleation* or shallow, uneven pitting, producing sometimes a sort of reticulation, not unlike that of some Nesopupae (*Indopupa*). The

straight angular lamella joins the lip weakly or scarcely. It *does not connect* with the parietal lamella, which is high but not very long. The columellar lamella is high on the columella, and ascends very slightly inward, being nearly horizontal. There are two short palatal folds, the lower being larger and somewhat more immersed. No basal fold. Peristome reflected and thickened moderately within. Length 2.2, diam. to edge of lip 1.2 mm.;  $5\frac{1}{2}$  whorls."

#### FAMILY PUPOIDIDAE.

The small pupoids assigned to this family are generally larger than the remaining Australian pupoid shells, and are either sinistral or dextral, rather stoutly built, not conspicuously sculptured, and with the mouth rather square the outer lip expanded, and a parietal lamina, which lies adjacent to the junction of the outer lip.

Genus **THEMAPUPA** Iredale 1930.

1930—*Themapupa* Iredale, Vict. Naturalist, Vol. 47, p. 120, November.  
Haplotype *Pupa beltiana* Tate.

The definition above given applies to the Australian members of the family.

**Themapupa contraria** Smith 1894.

1894—*Pupa contraria* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 96, June. East Wallaby Island, Houtman's Abrolhos (Walker).

1916—*Pupoides contrarius* Hedley, Journ. Roy. Soc. West Austr. Vol. I., p. 217 (68 in sep.).

1921—*Pupoides contrarius* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXVI. (pt. 103), p. 144 (not. pl. 15, figs. 9, 10 *eremicola*), August 4.

As this shell has not yet been figured, and we have no Abrolhos material, Smith's description is reproduced: "Shell sinistral, rimate, fuscous horny, obliquely very finely striate; whorls  $5\frac{1}{2}$ , convex, separated by a deep suture, the last whorl scarcely broader than the one preceding, ascending at the aperture; spire elongate, convex, pyramidal, subglobose at the apex; aperture one-third the total length; peristome white, expanded, margins joined by a thin callus, a tubercle near the insertion of the lip. Length 4.5, breadth 2 mm. Aperture 1.5 mm. long. This species may possibly prove to be the sinistral form of *P. adelaidae* Ad. and Angas, which is only known to me by the description."

*P. adelaidae* is obviously a larger shell, as is *eremicola* with which the present species was later associated.

**Themapupa sinistralis** Pilsbry 1921.

1894—*Pupa pacifica* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 96, June. Cassini I., N.W. Australia (J. J. Walker).

1921—*Pupoides pacificus* form *sinistralis* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XXVI. (pt. 103), p. 144, Aug. 4.

When Smith recorded the East Coast *pacifica* from North-West Australia he noted: "All the specimens from Cassini Island are sinistral; otherwise they resemble the normal form."

Pilsbry, in accepting this determination, observed that numerous specimens from all the other localities admitted furnished dextral specimens alone and recorded the Cassini Island shells as a form *sinistralis*, and this name may be used specifically to keep this shell under review.

***Themapupa lepidula* A. Adams and Angas 1864.**

Plate I., figs. 5 and 5a.

- 1864—*Bulinus* (*Chondrula*) *lepidula* A. Adams and Angas, Proc. Zool. Soc. (Lond.), 1864, p. 38, June 24. Shark Bay, W.A. Fig'd. Cox, Mon. Austr. Land Shells, p. 69, pl. XIX., f. 14, May, 1868, from a painting of the type by Angas.
- 1894—*Pupa lepidula* Smith, Proc. Malac. Soc. (Lond.), 1894, p. 96, June, cites "Cox, op. cit., p. 69 (unfigured)."
- 1916—*Pupoides lepidulus* Hedley, Journ. Roy. Soc. West. Austr., Vol. I., p. 217.
- 1921—*Pupoides pacificus* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXVI. (pt. 103), p. 141, August 4 (part).

This is a very distinct species judging from Cox's figure of the type which is here reproduced. Pilsbry rather carelessly included it in the synonymy of *P. pacificus*, observing, "It came from well within the known range" of that species, whereas it was well outside. Then he figured a specimen from Forrest River, near Wyndham, which was not much like Cox's figure, and noting that the lip was narrower concludes, "If this proves constant they might be separated as a race *lepidula*."

The original description is here added as no one has collected land-shells at Shark Bay in recent years: "Shell turritid, pupiform, umbilicate, thin, glossy, semipellucid, corneous; whorls 5 strongly convex, longitudinally striate. Aperture rotund-ovate; peristome interrupted, white, broadly reflected; outer lip provided above with a small, white, tuberculiform callus. Length 2, width 1 line. This little species differs from *C. adalaidae* in being semipellucid, shining and of a horn colour. The whorls, moreover, are much more strongly convex."

In view of the fact that species have been confused under the name *pacificus*, it is somewhat amusing to record a recent conclusion. Reusch (Zool. Jahrbuch. (Syst.), Jena Bd. 63, heft I., pp. 1-130, Apl. 12, 1932), led astray by a desire to recognise affinities without regard to local conditions, has proposed to admit one species *Pupoides coenopictus* Hutton, with an old-world range as follows:—

*P.c. coenopictus* Hutton. India, Ceylon, Afghanistan.

*P.c. senegalensis* Morelet. West Africa.

*P.c. connectens* nov. Sumba.

*P.c. pacificus* Pfeiffer. Australia, Islands of Torres Straits.

The idea of introducing a new subspecies, in an amalgam of such a composition, does not seem in accordance with his own theory of widespread "races." These "races" appear to be superspecies of other malacologists.

***Themapupa anapacifica* sp. nov.**

Plate I., fig. 9.

- 1874—*Bulinus pacificus* Smith, Zool. Erebus & Terror, Moll., p. 3, pl. IV., f. 6. Pigeon I. N.W. Australia (Richardson). Not *B. pacificus* Pfeiffer, Proc. Zool. Soc. (Lond.), 1846, p. 31.
- 1894—*Pupa pacifica* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 96, June. Pigeon I., near Wallaby I., Houtman's Abrolhos, West Australia; Roebuck Bay and Baudin I., N.W. Australia (J. J. Walker).

1921—*Pupoides pacificus* Pilsbry, Man. Conch., Ser. 2, Vol. XXVI. (pt. 103), p. 141, pl. 15, fig. 14 only, Aug. 4. Forrest River, East Kimberley District (Richard Helms).

The Western shell has been associated with *pacificus* by Smith, and Pilsbry, although the latter noted the discontinuous distribution, and figured as representative of a North Queensland island shell, specimens from Narrabri, inland New South Wales, Forrest River, West Australia, and apparently only one from Facing Island, almost in the south of Queensland. The last named, as would naturally be concluded, appears to be the nearest to the true *pacificus*. The Forrest River shell is here named. Shell small, pupoid, dextral, whorls convex, sutures deeply impressed, umbilicate, apex obtuse, coloration pale brown, outer lip white. The apical whorls are smooth, the adult whorls obliquely finely striated with threads, in some cases well marked, the mouth rather small. Length 4.25 mm.: breadth 2 mm.

***Themapupa dirupta* sp. nov.**

Plate I., fig. 8.

Mr. W. W. Froggatt collected a few specimens of a pupoid shell in the Barrier-Napier Range, and these break up the "*pacificus*" phantasy.

They are definitely of that association, but also perfectly distinct, being smaller than any of the so-called forms, measuring 3.5 mm. length by 1.5 mm. in breadth. The whorls are flatter than in the previous species though the sutures are deep, the shell darker coloured, the sculpture weaker, the mouth comparatively larger, the shell having a more squat appearance.

This is apparently the first inland representative in Australia of the "*pacificus*" series.

***Themapupa beltiana* Tate 1894.**

Plate I., figs. 3 and 6.

1894—*Pupa beltiana* Tate, Trans. Roy. Soc. South Austr., Vol. XVIII., p. 191, November. Central Australia.

Fig'd Rep. Horn Sci. Exped. Centr. Austr. (pt. 11.), Zool., p. 204, p. XVIII., fig. 15, Feb. 1896 (as dextral form of *P. contraria* Smith).

1921—*Pupoides contrarius beltianus* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXVI. (pt. 103), p. 145, pl. 15, figs. 5, 7, 8, August 4.

Apparently there is definite local variation in this species as well as individual variation, and a good series from Cardanumbi shows all the specimens to be broader than cotypes of *beltiana*. These may be regarded as a subspecies ***T. b. contexta* nov.** The type measuring 6 mm. in length by 2.75 mm. in breadth, some even being broader, whereas the type of *beltiana* was only 4.5 mm. in length by scarcely 2 mm. in breadth, paratypes being more slender still. A series from Nangeenan via Merredin collected by Mr. E. Sedgwick, shows a more conical form than any of Pilsbry's excellent figures, recalling a dextral fig. 9 (*contraria*). The shells are variable in size but all show the same shape, the whorls flatly rounded, the sutures deep, the angular nodule rather small, and may be called ***T. b. asserta*, subsp. nov.**, the type measuring 5.5 mm. in length and 2.5 mm. in breadth.

**FAMILY PUPILLIDAE.**

The usage of northern families for southern shells will probably later be as amusing to our successors as some of our predecessors' work is to ourselves. Nevertheless it is necessary to have some refuge for these waifs, and therefore the above is here used with reservation.

Genus **OMEGAPILLA** Iredale 1937.

1937—*Omegapilla* Iredale, Austr. Zool., Vol. VIII., p. 304, March 12. Orthotype *Pupa nelsoni* Cox.

Small pupoid shells, dextral or sinistral, mouth small, teeth three or four, differently arranged from those of other Pupoids, though obviously correlative.

Hedley placed this in the European genus, *Vertigo*, while Pilsbry includes it in the Palaearctic genus, *Pupilla*, under a section, *Primipupilla*, based on a Caucasian shell, but later discarded this in favour of *Gibbutinopsis* Germain, proposed for an "Enneid" shell from the Island of Reunion.

I reiterate my conclusion that the association of southern Australian Pupoids with those from Europe and South Africa is basically unsound, and should not be recognised by Australian conchologists.

***Omegapilla occidentalis* sp. nov.**

Plate I., fig. 10.

1894—*Pupa lincolniensis* Smith. Proc. Malac. Soc. (Lond.), Vol. I., p. 961, June. Pigeon Island, near Wallaby Island (Dr. Richardson, in British Museum), and East Wallaby Island, Houtman's Abrolhos (Walker).

1916—*Vertigo lincolniensis* Hedley, Journ. Roy. Soc. West Austr., Vol. I., p. 217 (p. 68 in separate).

1921—*Pupilla australis* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XXVI. (pt. 104), p. 218.

Smith remarked "This species is described [by Cox (Mon. Austr. Land Shells, p. 80, pl. XV, fig. 16, May, 1868; Port Lincoln, South Australia)], as having only a single tooth or tubercle in the aperture. The specimens collected by Dr. Richardson and Mr. Walker have a second basal tubercle as indicated in Cox's figure, and a third far within upon the columella. It is possible that in the examples examined by Dr. Cox the denticles were only feebly developed, or they may even have been overlooked, being rather indistinct."

Many specimens from Rottnest I. are much smaller than South Australian *lincolniensis* or *australis*, and have the teeth placed much further back and less noticeable, the parietal tooth most pronounced, the columellar one smaller and more hidden, the basal one well inside.

**FAMILY SUCCINEIDAE.**

This family is at present allowed a world-wide range, but this is questionable, and recent researches into British forms show distinct groups definable in that small compact area. I have therefore introduced the generic name *Austrosuccinea* for the common southern Australian type as the animal has been shown to differ from that of the northern group whose shell is most like. For a second peculiar Australian group I have proposed *Arborecinea*: both these occur in Western Australia but there may be a third later separated.

Genus **AUSTROSUCCINEA** Iredale 1937.

1937—*Austrosuccinea* Iredale, Austr. Zool., Vol. VIII., p. 307, March 12, Orthotype *Succinea australis* Ferussac.

The waxy appearance and peculiar form make these molluscs recognisable at sight. Subbulimoid in form with a very short spire and open oval



mouth, imperforate, texture very thin, the outer lip fragile, sculpture of rude growth radials, sometimes with fine subordinate lining.

**Austrosuccinea scalarina** Pfeiffer 1861.

Plate I., fig. 11.

1861—*Succinea scalarina* Pfeiffer, Proc. Zool. Soc. (Lond.), 1861, p. 28, May 1. King George's Sound, South-West Australia. Fig'd. Cox, Mon. Austr. Land Shells, p. 89, pl. XX, fig. 19, May, 1868, from a painting of the type by Angus.

"Shell ovately conical, scalarine, rather solid, irregularly rugosely plicated, slightly shining, reddish; spire elongated, rather acute; whorls  $3\frac{1}{2}$ , convex, last slightly exceeding the spire, somewhat attenuated at the base; columella receding, nearly straight, forming with the peristome an indistinct angle; aperture oblique, oval, scarcely angular above, peristome simple, columellar margin slightly reflected above."

Such is the description of a *Succinea*, and is here reproduced as a standard. The shell is reddish when alive but commonly fades to horny, the solidity is usually missing, thin and fragile better describing the species; length 15 mm.; breadth 7.5 mm.; length of aperture 9 mm.

**Austrosuccinea contenta** sp. nov.

Plate I., figs. 12 and 13.

1843—*Succinea oblonga* "Dr." Menke, Moll. Nov. Holl. Spec., p. 6 (Apl. 11), *nom. nud.*, in cracks of limestone rocks not far from the sea near Perth.

1844—*Succinea oblonga* Menke, Zeitschr. für. Malak. (Menke), 1884, p. 56, Apl. 10. New Holland specimens described.

Not *Succinea oblonga* Draparnaud, Tab. Moll. France, p. 56, 1801.

Probably there are many species in the Perth district, but obviously Menke's name was used for the common one.

This has a short spire with a rather swollen body whorl, the spire shorter than that of *scalarina* and the body whorl a little broader; the shell is not so rugose, the early whorls being much smoother, the inner lip is a little thickened and a slight body glaze connects with the outer lip. The length of the type is 11 mm., the breadth 7 mm., the length of the aperture 8 mm.

Specimens from Rottnest Island appear to differ in their narrower form, less swollen body whorl, longer spire and may represent a distinct subspecies, *A. contenta isolata* subsp. nov., but this will be more fully discussed later. The type measures 11 mm. in length, 6 mm. in breadth and the aperture 6.5 mm. in length.

**Austrosuccinea caurina** sp. nov.

Plate I., fig. 16.

1895—*Succinea scalarina* Hedley, Proc. Malac. Soc. (Lond.), Vol. I., p. 260, July. Fitzroy River, North-West Australia.

1898—*Succinea scalarina* Ancey, Proc. Linn. Soc. N.S.W., Vol. XXII., (1897), p. 777, June 4. Lennard River, 100 miles inland from Derby, North-West Australia (W. W. Froggatt).

This north-western species which has been confused with the south-western one has a general superficial resemblance to that, but is smaller, nar-

rower and lacks the rugose plications. This reads very similarly to the description of *strigillata* but the shape is different.

Shell elongate, rather narrow, spire moderate, attenuate, mouth oval not much expanded, sculpture weak, early whorls almost smooth. The whorls are rounded, but not strongly convex, the sutures fairly deep. There is very little body glaze connecting the inner and outer lips. Length of type 12 mm., breadth 6.25 mm., length of aperture 7 mm.

***Austrosuccinea strigillata* A. Adams and Angas 1864.**

1864—*Succinea strigillata* A. Adams and Angas, Proc. Zool. Soc. (Lond.), 1864, p. 38, June 24. Shark Bay, West Australia.

Fig'd. Cox, Mon. Austr. Land Shells, p. 89, pl. XV., fig. 5, May, 1868.

No specimens are available from Shark Bay so the original description is here given: "Shell ovately conical, thin, semi-pellucid, pale horny yellow; spire scarcely equalling the aperture; apex papillary; whorls  $3\frac{1}{2}$ , strongly convex, longitudinally finely and minutely striated; aperture oblong ovate; left margin with a long thin callus deposit, right simple. Length 5 lines, breadth  $2\frac{1}{2}$  lines. A species somewhat allied to *Succinea strigata* Pfr., from South Australia, having the same papillary apex; but differing in being smaller, thinner, of a lighter colour, and in the whorls being less strongly rugose."

Smith (Proc. Malac. Soc. (Lond.), Vol. I., p. 97, June, 1894) has recorded *Succinea scalarina* from E. Wallaby I., Houtman's Abrolhos, W.A., and given a figure but whether this be from the type of *scalarina* or from an Abrolhos shell is not stated. At present as no specimens are available the identity of the island form cannot be ascertained.

***Austrosuccinea aridicola* sp. nov.**

Plate I., fig. 15.

Shells collected at Boulder by W. D. Campbell are unlike any of the coastal forms, but still more unlike the Centralian *interioris*. Shell small, elongate, spire long, mouth short of moderate expansion, whorls very rounded, sutures very deep. The shells are dead, the periostracum missing, the sculpture weakly strigose, the strigations still notable on the early whorl. The spire is almost as long as the aperture, the latter being rather a regular oval, the inner lip connecting with a body glaze to the outer lip, which is thin as usual. Length 10.5 mm., breadth 6 mm., length of aperture 5.5 mm.

***Austrosuccinea coxi* Finlay 1927.**

Plate I., fig. 17.

1927—*Succinea coxi* Finlay, Trans. New Zeal. Inst., Vol. 57, p. 521, Jan. 19, new name for

1868—*Succinea aperta* Cox, Mon. Austr. Land Shells, p. 90, pl. XVII., fig. 6, May. King George's Sound, West Australia (Masters).

Not *Succinea aperta* Lea, Trans. Amer. Phil. Soc., Vol. VI., p. 101, 1838.

This species is recognisable at sight by the large mouth which is the bulk of the shell, the spire being only one-third the length of the aperture. From conchological features alone it deserves separation subgenerically as ***Cerinasota* nov.**, and it is fairly certain that the anatomy will necessitate a higher value.

Genus **ARBORCINEA** Iredale 1937.

1937—*Arborcinea* Iredale, Austr. Zool., Vol. VIII., p. 308, Mch. 12. Ortho-type *Succinea eucalypti* Cox.

The tree living Succineids have very different habits from those on the ground which frequent damp places, and it has been recently argued that field observations must be taken into account in the taxonomic disposition of our molluscs. I recorded many years ago that on Sunday Island, Kermadec Group, the tree living snails were altogether unrelated to those living on the ground adjacent. In the present series the tree living Succineids live under the bark of the trees and seal themselves to the wood, carrying a thick epiphragm. Normal Succineids with a large animal live in moist places, and many kinds have been separated among those alone. The shell features of *Arborcinea* include a short spire, swollen body whorl and a rather bold sculpture with a truncate thickened columella.

***Arborcinea menkeana* Pfeiffer 1850.**

Plate I., fig. 14.

1843—*Succinea amphibia* "Dr." Menke, Moll. Nov. Holl. Spec., p. 6, Apl. nom. nud. "Under the Bark of Eucalypts." District Hay, West Australia.

1844—*Succinea amphibia* Menke, Zeitschr. für Malak (Menke), 1844, p. 55, Apl. 10. Specimens described.

Not *S. amphibia* Draparnaud, Tab. Moll. France, p. 55, 1801.

1850 —*Succinea menkeana* Pfeiffer, Zeitschr. für Malak (Menke), 1849, p. 110, Jan. 1850, fide C.D.S. New Holland (L. Preiss) = *amphibia* Menke, i.e., from Hay as above.

Fig'd. Pfeiffer, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XI., p. 45, pl. 4, figs. 36, 37, 38. 1855.

1930—*Succinea brevissima* Thiele, Die Fauna Südwest Australiens, Bd. V., lief. 8, p. 587, pl. IV., f. 66. Collic, South-West Australia.

The description indicates the genus thus "Shell ovately-elliptical, thin, distinctly striated, pellucid, shining, horny; spire short, papilliform, suture deep; whorls  $2\frac{1}{2}$ , the last but one very convex, the last attenuated at the base; columella somewhat callous, regularly curved; aperture slightly oblique, regularly oval; peristome simple, thin, margins approaching. Length  $3\frac{1}{2}$  lines; breadth  $1\frac{1}{2}$  lines."

**FAMILY BOTHRIEMBRYONTIDAE.**

Probably the most intriguing land shells in Australia are the bulimoid forms inhabiting the South-West corner. A large number of species and races has developed, and probably only a tithe has been described. It is unfortunate these have not yet been studied by anyone conversant with local conditions, and it is certain that they will provide future students with much research. No more exciting subject could be chosen by the student, but the unravelling of the many problems will necessitate much investigation. The present essay, also by an outsider, is the result of over a dozen years of consideration, the specimens having been handled from every viewpoint, geological data, botanical data, meteorological data and even soil conditions have been brought under review. The first species were described from the collections of the French naturalists; a little later similar shells taken by British

explorers being made known. A German naturalist then collected some specimens, and these, of course, were dealt with by German conchologists. Some time later Cox, the Sydney conchologist, listed the species in his Monograph, but was content to indicate the various varieties only. Hedley attempted to arrange the forms but did not publish his conclusions.

A real attempt to systematise them was made by the inimitable American malacologist, Pilsbry, in the "Manual of Conchology." To assist him, Cox sent him a large collection but unfortunately the bulk of that collection was labelled "King George's Sound," the name covering all the adjacent locality within a radius of a hundred miles or so. Thus Pilsbry was baffled with the great variation in the shells from this locality. It is indeed fortunate that the Cox collection, including the specimens handed by Pilsbry, is now in the care of the Australian Museum, and has been utilised in this study. A year or so later the German monographer, Kobelt, dealt with this group, and in the main followed Pilsbry, but did not realise the value of exact localities. In the future the science of geozoology will probably play a great part in the elucidation of this group, as the species and even higher groupings appear to be living in government by their geological and botanical environment, with, of course, the rainfall being a matter of importance.

The Bothriembryontids vary in size from about 25 mm. to 50 mm. in length, from very narrow to plump in form, and from almost smooth to heavily granose sculpture. It is probable that future investigators will discover anatomical features in the animal to assist them, but at present only the shells are available for examination.

The notable variations are easily seen, as *dur*, *indutus*, *melo*, *onslowi*, *kingii* and *gratwickii*. According to Pilsbry's researches these appeared to show different apical features so that as a guide for future investigators I introduced subgeneric names, *Hartogembryon* for *onslowi*, and *Satagembryon* for *gratwickii*. The type of *Bothriembryon* is *melo*, and *Hartogembryon* seems to be an offshoot from this source, while *Satagembryon* may be a specialised product of the *kingii* root. However, *dur* and *indutus*, the two largest forms, are thus left nameless, and while the latter may be related to the *melo* branch, it is now differentiated clearly, and is here subgenerically named **Dialembryon**. The source of *dur* is at present indeterminable, and a subgenus **Ponembryon** is here proposed to distinguish it. As *Satagembryon* is so abnormal, a subgenus **Telembryon**, is introduced for the normal *kingii* series. By the usage of these subgeneric names, and the allotment of the named species will secure greater accuracy and lead to a better knowledge of this interesting series of land-shells. It must be pointed out, however, that though *dur* and *indutus* are in no danger of confusion, there are some shells that appear to link together *kingii* and *melo*, but better material and more local knowledge might easily dissipate the clouded outlook of the extralimital struggle for light in this delightful molluscan group.

The Bothriembryontids are practically confined to the south-west corner of Western Australia, which I have called the Leeuwinian Area, and constitute a remarkable element of the Autochthonian Faunula. Northwards the group reaches Shark Bay, there mingling with the outliers of the Caurine Faunula of the Dampierian Sub-Area. Eastwards a few members range along the southern sea coast of the Centralian or Larapintine Area, while one form is found in the middle of this Area, among the true representatives of the Eremian or Eyrean Faunula. Now, in this Leeuwinian Area the groups abovenamed already seem to be limited in their distribution. Thus we have *Telembryon* from Vasse just north of Cape Naturaliste, then cling-

ing to the coast from there to Cape Leeuwin and thence still coastwise to 70 miles east of Israelite Bay. Though apparently a coastal group, it has not been collected yet on the islands of the Recherche Group, although one species comes from Doubtful Island, a coastal islet. On the other hand, the true *Bothriembryon* is abundant on the islands of the Recherche Group and the mainland adjacent, and then from King George's Sound seems to make an inland march across to Perth. It has not yet been recorded from the Stirling Ranges where a peculiar *Telembryon* lives alongside *Dialembryon*. The range of this last-named group is peculiar, species being known from the Darling Ranges inland from Perth, the Stirling Ranges and the hazel scrubs a little west of King George's Sound. Still more curious is the distribution of the giant *Ponembryon*, which appears somewhere about King George's Sound and occurs eastward to the Fraser Range. This leaves *Hartogembryon* and *Satagembryon*, which are localised, and as above noted these may be only specialised offshoots from *Bothriembryon* and *Telembryon* respectively. A glance at a rainfall chart will show that these larger groups are *not* governed by present-day rainfall, though investigation suggests that species vary in accordance with the annual rainfall. Furthermore, it seems that certain trees live under certain geological conditions, and that some of these snails are associated with definite botanical formations. This cannot be definitely asserted as there are too little data, but it would be a good line to follow.

The species are easily distinguishable, but there is a lot of individual variation. No mechanical method of diagnosis can be used, though examination of series enables differentiation with ease. Consequently the norm of the series is here described and the connectant variation recorded, but specimens must be available for comparison and recognition. Figures without confirmative shells can prove very misleading, whereas topotypes are of very definite value and few mistakes will be made in their use.

Genus **BOTHRIEMBRYON** Pilsbry 1894.

- 1894—*Bothriembryon* Pilsbry, Nautilus, Vol. VIII., p. 36, July. Orthotype *Bulimus melo* Quoy and Gaimard.
- 1861—*Liparus* Martens, Die Heliceen (Albers), 2nd ed., p. 229. Orthotype *Bulimus inflatus* Lamarck.
- Not *Liparus* Albers, Die Heliceen, 1st ed., p. 172, 1850.
- 1933—*Hartogembryon* Iredale, Rec. Austr. Mus., Vol. XIX, p. 41, Aug. 2. Orthotype *Bulimus onslowi* Cox.
- 1933—*Larapintembryon* Iredale, Rec. Austr. Mus., Vol. XIX, p. 41, Aug. 2. Orthotype *Liparus spenceri* Tate.
- 1933—*Satagembryon* Iredale, Rec. Austr. Mus., Vol. XIX., p. 41, Aug. 2. Orthotype *Bulinus gratwicki* Cox.

The characters of the genus, as here used, are those already fully detailed in connection with the family just preceding.

***Bothriembryon melo* Quoy and Gaimard 1832.**

Plate II., fig. 1.

- 1832—*Helix melo* Quoy and Gaimard, Voy Astrol. Zool., Vol. II., p. 109, pl. 9, figs. 4-7. Summit of Bald Head, King George's Sound, South-West Australia.

- 1832—*Helix melones* id. ib., in synonymy, ex Ferussac, Tabl. Syst. Limaçons, Prodr., p. 58, Jan.: p. 54, June, 1821 (*Helix*) (*Cochlogena*) *melones* nom. nud. cf. Potiez & Michaud, Gal. Molus. Mus. Douai, Vol. 1., p. 147, pl. XIII., fig. 15-16, 1838.
- 1838—*Bulimus ovum* Deshayes, Règne Animal (Cuvier) Disciples ed. pl. 23, fig. 1, Quoy MS. ? error only for *melo*.
- 1839—*Bulimus melo* Sowerby, Zool. Beechey's Voy., p. 145, pl. 38, fig. 16. "n.2 error."
- 1843—*Bulimus melo* Menke, Moll. Nov. Holl., Spec. p. 7, April "four varieties described. Among Melaleuca in Hay district.
- 1843—*Bulimus physodes* Menke, id., ib., as synonym of var. a. of the preceding.
- 1844—*Bulimus melo* Menke, Zeitschr. für Malak. (Menke), 1844, p. 56, April 10. The above varieties discussed, and var. a. recognised as typical *B. melo* Quoy & Gaimard.
- 1859—*Bulimus melo* Pfeiffer, Mon. Helic. viv., Vol. IV., p. 477, six varieties differentiated, but not named.
- 1868—*Bulimus melo* Cox, Mon. Austr. Land Shells, p. 74, pl. XIII., fig. 6, May.
- 1892—*Liparis inflatus*, with vars. *melo*, *physodes*, *castaneus*, *bulia* and *rhodostoma*, Hedley, Rec. Austr. Mus. Vol. II., p. 29, Aug.
- 1900—*Bothriembryon inflatus* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 3, pl. 1, figs. 1-5. apex, pl. 4, figs. 73, 74, April 23 and var. *melo*, p. 4, pl. 1, figs. 7-10, (other vars. not referable here).
- 1900—*Bothriembryon physoides* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XIII., p. 9, pl. 2, figs. 35-36-37, Apl. 23.
- 1901—*Bothriembryon physalis* Kobelt, Syst. Conch. Cab. (Mart & Chemn.), ed. Kuster, Bd. I., Abth. XIII (2), p. 778 (28: vii: 1907) error only.

Shell elongately conical, rather plump, spire conical not quite as long as aperture, whorls rather flattened, sutures lightly impressed, last whorl two-thirds the length of the shell, mouth oval, elongate, lip thin, columella straight, reflected, hiding, but not closing, a deep narrow umbilicus.

The coloration is commonly unicolor, pale fawn, sometimes with a sub-natural reddish band and red longitudinal streaks but never with a red circum-bilical patch. Dead shells are white as the coloration lies in a very fine periostracum.

The apex is rather flattened, of two whorls, the sculpture of fine punctuation or thumbing as it is sometimes termed, this being coarser than that of the Swan River *bulia*; the adult sculpture consists of radial growth lines, irregular and wavy, becoming less marked on the last whorl. On the early whorls there is a faint concentric sculpture also seen but this is never notable and usually vanishes early. Length 26 mm., breadth 15.5 mm. This description is drawn up from specimens from the type locality, where a great deal of colour variation is not seen. As related below, many shells have been regarded as answering to the original nominations, but as now restricted the above applies exactly.

The confusion in connection with the common King George's Sound shell has lasted since its discovery. A similar shell was found in the Perth district, and another not a great deal unlike at Shark Bay. Apparently Ferussac distinguished these, and Lamarek confused them, and then Quoy

and Gaimard re-recognised Férussac's form. Menke, however, could not understand them, and added some more species. Collections did not solve the problems, as the localities whence the shells came were not accurately distinguished. Hence we have the great authority on land-shells of eighty years ago, Pfeiffer (Mon. Helic. viv., Vol. IV., p. 477, 1859), allowing one species under the name *melo*, but arranging six varieties, which he did not systematically name, but used phrases only. The first words were afterwards recorded as varietal names, and these read *castaneus*, *luteus*, *major*, *albidus*, the fifth without a distinctive adjective to begin with, and the sixth, *tenius*, citing *physodes* Menke as equivalent. No localities were known for these different variations, and it is now impossible to determine these varieties. Cox mentioned Menke and Pfeiffer, and that he could add more varieties, but did not give any names. Hedley arranged the shells in the Australian Museum and gave names to two colour varieties as was the custom then, but did not publish these when he listed the species under the name *Liparus inflatus* Lamarek, with varieties, *melo* Q. & G., *physodes* Menke, *castaneus* Pfeiffer, *bulia* Menke and *rhodostoma* Gray. Pilsbry introduced the new generic name *Bothriembryon*, and using *inflatus* as the specific name, admitted as varieties *melo* Q. & G., *castaneus* Deshayes, and added var. *maculiferus* and var. *conspira*, allowing *physodes*, *bulia* and *rhodostoma* as different although he could not recognise the two last-mentioned. Kobelt did not know what to do, so recorded most of these following Pilsbry's descriptions, but not admitting his valuation. His account is too confused to need much discussion, his descriptions and figures being hereafter allotted as far as possible.

***Bothriembryon castaneus* Pilsbry 1900.**

Plate II., fig. 2.

1900—*Bothriembryon inflatus* var. *castaneus* Pilsbry, Man. Conch. (Tryon), Ser. 2., Vol. XIII., p. 5, pl. I., figs. 11, 18, April 23, ex Deshayes MS. (citing Vol. VIII., p. 245, Lamarek, Hist. 2nd ed., where it does not occur). King George Sound, West Australia—Doubtful Island, South-West Australia.

Quoy and Gaimard figured as a variation of their *Helix melo*, a narrower brown shell with a broad white peripheral band. This variation was included by Deshayes, but he did not assign it any name, writing, "var. (ietas) castanea: vitta cineta alba." Pilsbry used the name *castaneus* as a varietal one, copying Quoy and Gaimard's figure, but describing a specimen sent by Dr. Cox, which he also figured. I am selecting the latter as the type of Pilsbry's *castaneus*, as it was one of a series from Doubtful Island, and his specimen is here refigured. The Doubtful Island shells are constant in coloration and size, the sculpture being a little stronger, and the size a little less. Length 23 mm., breadth 12.5 mm.

***Bothriembryon rhodostomus* Gray 1834.**

Plate II., figs. 3-7.

1834—*Bulimus rhodostomus* Gray, Zool. Soc. (Lond.), 1834, p. 67, November 25. New Holland (probably collected by Robert Brown at Goose Island, Recherche Group, W.A.).

Not *Bulimus rhodostoma* Reeve, and later authors.

1900—*Bothriembryon inflatus* var. *maculiferus* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 5, pl. I., figs. 12-14, Apl. 23. "King George Sound, South-West Australia." = Recherche Group based on a shell collected by Rossiter.

1901—*Bothriembryon martensi* Kobelt, Syst. Conch. Cab., (Mart. & Chemn.) ed. Kuster, Bd. I., Abth. 13 (2), p. 764, pl. 112, figs. 3, 4, (sheet dated 21 VI. 1901). New Holland.

Through lack of specimens this species has been overlooked, a different species being figured by Reeve, but with doubt, yet he has been followed. If the description had been studied, the shell would have been recognised as it is really quite good: "Shell ovate, perforate, solid, striate, whitish marbled with rose, cuticle thin, olivaceous, suture delicately circulated; whorls with two obscure posterior bands; throat roseate; peristome a little thickened; axis anteriorly deep brown. Axis  $1\frac{1}{4}$ ; diam.  $\frac{3}{4}$  unc."

The size and proportions do not fit any other species than the following. When it is realised that Robert Brown was on Goose Island, one of the Recherche Group, where this kind of shell is common, its recognition is easy. Reeve figured a different shell under Gray's name, but he doubted the association, and he was right in that doubt, as his specimen almost certainly came from the Perth district. Rossiter also collected specimens in the Recherche Group, and one of these was named by Pilsbry as the Coxian locality "King George's Sound" misled him. The remainder of Rossiter's specimens in the Brazier collection are labelled "Recherche Group."

One of the most interesting revelations of Australian conchological science was made by Mr. A. F. Basset Hull, who visited the Recherche Group, with the assistance of Messrs. Henry Grant and J. H. Wright of the Australian Museum. Many specimens were collected on the mainland at Esperance, and on the eastern islets of the Archipelago. They found that each locality showed a definite variety, and these are illustrated and diagnosed here.

At first sight these recall the King George Sound *melo*, but are larger, and restricting *rhodostomus* to the western islands of the Recherche Archipelago, those from the eastern ones are here described.

The Gunton Island shells may be called ***B. rhodostomus hullianus*** subsp. nov. The ground colour is pale brownish cream, a reddish brown band below the suture followed by a pale band, and then another reddish brown band above the periphery with a similar red brown patch around the umbilicus. The aperture generally pale creamy white inside, sometimes purplish, the columella pale or dark purplish brown, rarely white. A strong wrinkling below the suture gives the subsutural red band a streaked appearance. In form, they are roundly elongate, the spire being about equal in length to the aperture. Some thirty specimens are still available, of which two are unicolor, the others constant. The variation in measurements is: 35 mm. in length by 18 mm. in breadth (type), 34 by 20, 34 by 17 and 31 by 20 mm. One shell from Rob Island (Mondrain) is smaller with the ground colour pinkish white, heavily streaked with purplish brown, the aperture and columella purplish, and probably comes nearest true *rhodostomus*.

A longer series from Charley Island shows more variation, the darker shells being brownish cream, longitudinally heavily streaked with dark brown, some are less heavily marked, the streaking being fewer, and bands showing through so that one almost agrees with the Gunton Island shell, and some are even unicolor. In the other direction, the streaks tend to coalesce until the last whorl is practically uniform dark purplish brown. The aperture varies in coloration, according to the exterior, from white with a rose columella, and outer lip internally, through pale reddish to dark purple. In shape some are comparatively plump while others have the spire lengthened,



but in none is the spire shorter than the aperture. Measurements read length, 40 mm. by breadth, 20 mm. (type), 38 by 22, 38 by 20, 35 by 20 to 32 by 20. These may be called *B. r. grantianus* subsp. nov. Another fine series from Rabbit Island (not Rabbit Island in King George's Sound) are similar in size and form to the preceding, but are paler throughout, and are here named *B. r. wrightianus* subsp. nov. The markings are always paler, and pallid shells are more numerous, while these are generally smaller, all the largest ones being streaked. Only one approaches the normal Gunton Island form coloration, and the measurements of the streaked shells are length 36 mm. by breadth, 21.5 mm. (type), 36 by 20, and 35 by 21 mm., while the pale unicolor shells measure 34 by 21, 34 by 20 and 33 by 17 mm. The shells from Woody Isle are a little smaller, with a pale cream zone below suture, and a pale patch on base, the whorl being brown streaked with dark purplish brown, the streaks almost coalescing on the last whorl and forming a broad band. The measurements are, length, 31 mm. by 17 mm., and 30 mm. by 18 mm. This may be called *B. r. perspectus* subsp. nov., and this leads to the mainland Esperance form.

The mainland shells, collected commonly at Esperance, recall *melo*, but are generally larger and paler. Pilsbry has figured this as *maculiferus*, fig. 14, but as his figs. 12 and 13 of *maculiferus* are alike in colouring, and are larger and are part of a lot from the Recherche group, *maculiferus* becomes a synonym of *rhodostomus*.

Some hundreds of shells were collected at Esperance crawling on grass and bushes after rain, and these are quite constant, although the streaks vary in number, the colouring is pale, and none is dark as the island forms, and this is here described as a distinct species.

***Bothriembryon esperantia* sp. nov.**

Plate II., fig. 8.

Shell plumply elongate, not as broad as *bulla*, with less sculpture, the spire conical as long as the aperture, whorls rounded, the columella reflected over the umbilicus but still leaving a notable chink, shell solid. Coloration greyish white sparsely flamed with irregular streaks of dull pinkish brown, the ground colour dominating the coloration. Apex finely punctate, a little more elevated than that of typical *melo*, the adult sculpture rough, irregular radial growth ridges with very little cross sculpture and no decussation notable in some cases: in other rather coarsely granulose as the one described and figured by Pilsbry (p. 6, pl. I., fig. 14) which is here refigured, the form and coloration being diagnostic. Length 23 mm., breadth 15 mm. The largest measures 26 mm. by 16 mm.

***Bothriembryon balteolus* sp. nov.**

Plate II., fig. 9.

Many shells from the Esperance Mallee Belt district, 50 miles south of Norseman, Madura, Salmon Gums, are all dead and agree in showing a strong banded coloration.

In form the shells recall *bulla*, but the spire is not so exsert and they must be near to *rhodostomus* geographically. The shells have the spire definitely less elate than the Esperance coastal species, with the sculpture more regular almost producing a cancellation on the penultimate whorl and shoulder of the last whorl. The ground colour is chalky-white with a narrow purple peripheral band and a large purple circumbilical patch. The columella is

reflected almost covering up the umbilicus, the outer lip thin, and a glaze connects the inner lip to the outer lip across the body whorl. The apex is eroded but shows the coarse pitting of the *melo* series. Measurements—length 21 mm., breadth 15 mm. (Esperance Mallee Belt). The range of this form inland would be interesting, as we might get intermediate localities between this and the Centralian *spenceri*. From Newman Rocks shells are a little more globose, spire shorter, and the colours reversed, being pale brown with a peripheral white band recalling *castaneus*, but differing in sculpture. Bednall (Trans. Roy. Soc. South Austr., Vol. XVI., p. 66, Dec., 1892), recorded *Bulimus melo* Q. & G. from the Fraser Range, from dead shells alone: this report may refer to specimens of this species.

***Bothriembryon serpentinus* sp. nov.**

Plate II., fig. 10.

A large series of shells collected alive by Mr. L. Glauert at Serpentine Falls, Darling Range, all agree in form and coloration though varying a little in proportions. Thus some are shorter recalling the coastal *bulia*, and others are elongate similar to *indutus*, but very unlike in shell texture. These are thin and are pale brownish-yellow thickly longitudinally streaked, being thus referable to the *bulia* style rather than to the *indutus* series. The apex is finely punctate the succeeding whorls rounded, the spire about equal to the mouth, four adult whorls succeeding the two punctate whorls sharply. The columella is reflected, brownish purple, leaving a very small umbilical fissure, the outer lip thin, the aperture brown within. Sculpture, rough closely set irregular radials overrun by concentric lines, almost forming a distinct cancellation on the earlier whorls. A couple picked at random give measurements—length 25 mm., breadth 16 mm., and length 32 mm., breadth 16 mm. The shell figured (type) measures 28 mm. in length and 16 mm. in breadth. The locality falls into the 30-inch annual rainfall belt.

***Bothriembryon praecelsus* sp. nov.**

Plate II., fig. 11.

One specimen from Kellerberrin may be immature, but it is large and very distinct from any shell from the Darling Ranges or the Perth district. The locality is inward of the ranges, and lies in the 10-15 inches rainfall belt.

The shell is inflated but the spire is conical and short, the aperture a little longer than the spire and open, shell very thin. Coloration almost uniform being brown, growth lines lighter. The apex is worn but shows a flattened two whorls stopping suddenly so that almost a varix appears: there is a reticulate pitting now seen. The adult sculpture consists of fine radials crossed by fine concentric lines almost cutting the radials into lozenges, these vanishing below the shoulder on the last whorl, only the rather rude radials persisting. The columella is white, reflected, almost concealing the umbilicus, a very slight glaze crossing to the edge of the outer lip which is thin. The measurements read—length 29 mm., breadth 20 mm., length of aperture 17 mm., breadth of aperture 10 mm.

***Bothriembryon sedgwicki* sp. nov.**

Plate II., fig. 12.

Shell small, spire conical, shorter than aperture, body whorl swollen, umbilicate, but only slight chink remains, shell thin. Coloration brown marked with irregular longitudinal streaks of dirty white which are the

elevated radial ribbing. Apex typical of the *bulia* style, finely punctate, adult sculpture of rough radials, cut by concentric lines forming a subnodulose sculpture, the concentric lines disappearing on the base of the last whorl. Height 17 mm., breadth 11 mm.

Mr. E. Sedgwick, who collected this interesting form at Nangeenan via Merredin, sent a series including juveniles, which are merely the apical whorls, punctate, horny, umbilicate; the next stage shows the adult sculpture forming, succeeding a slight but distinct varix, and at this stage capable of making a perfect epiphragm. On the next whorl the concentric lines appear to be bearing fringes, but these are absent in the adult.

**Bothriembryon bulia** Menke 1843.

Plate II., fig. 13.

- 1843—*Bulimus bulia* Menke, Moll. Nov. Holl. Spec., p. 7, April. Darling Range, West Australia.
- 1844—*Bulimus bulia* Menke, Zeitschr. für Malak. (Menke), 1844, p. 57, April 10.
- 1848—*Bulimus rhodostoma* Reeve, Conch. Icon., Vol. V., pl. xlix., sp. 323. Nov. New Holland.
- 1854—*Bulimus baconi* Benson, Ann. Mag. Nat. Hist., Ser. 2, Vol. XIII., p. 99, Feb. 1. Darling Range, West Australia.
- Fig'd. Cox, Mon. Austr. Land Shells, p. 73, pl. xix., fig. 13, May, 1868, from a painting of the type by Angas. Refig'd. Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 95, pl. vii., fig. 32, June, 1894 (type).
- 1892—*Liparus inflatus* var. *bulia* Hedley, Rec. Austr. Mus., Vol. II., p. 29, August.
- 1892—*Liparus inflatus* var. *rhodostoma* id. ib.
- 1892—*Liparus baconi* id. ib.
- 1900—*Bothriembryon inflatus* var. *conspira* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XIII., p. 6, pl. 1, figs. 15-17; apex, fig'd. pl. 4, figs. 71-72, April 23. "King George's Sound, W.A." error = Perth.
- 1900—*Bothriembryon bulia* id. ib., p. 15.
- 1900—*Bothriembryon baconi* id. ib., p. 16, pl. 2, fig. 42.
- 1901—*Bothriembryon baconi* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. 1., Abth. 13, Theil 2, heft CLXV., lief. 463, p. 770, pl. 112, fig. 18; pl. 116, fig. 6, sheet dated 8-7-1901.
- 1901—*Bothriembryon bulia* id. ib., heft CLXVIII., lief. 467, p. 777, pl. 113, figs. 15-16, sheet dated 10-7-1901.
- 1901—*Bothriembryon rhodostoma* id. ib., p. 786, pl. 114, fig. 6, sheet dated 28-7-1901.
- 1902—*Bothriembryon durus* id. ib. heft CLXXIII., lief. 473, p. 930, pl. 131, figs. 1-2, sheet dated 8-4-1902. Probably Australia.

Shell elongate, plump, spire conical, short, last whorl plump, not obese, shell thin, whorls rather flattened, last whorl very large, mouth broad oval, elongate, outer lip thin, columella straight, reflected, hiding umbilicus which however, still remains open but narrow. Coloration somewhat varied, a greenish appearance prevailing: the background pale green finely streaked with reddish brown and a pale peripheral band overrun however by the streaking: sometimes the green prevails and there is almost a uniform shell but this is rare. At others the red is predominant and the shell takes on a

reddish tone, but always the coloration is characteristic. The apex is punctate, the thinning finer than in the southern *melo*: the longitudinal irregular ribbing is cut into nodules by the concentric lining and there is commonly a notable deep line just below the suture which is never seen in *melo*, the sculpture being much more pronounced in this species. Some specimens elongate with age and thus we get Reeve's "*rhodostoma*" and Pilsbry's *conispira*. The normal shell measures 25 mm. in length by 16.5 mm. in breadth, *conispira* being 25 by 14.5 mm., and others up to 28 mm. by 16.5 mm.

***Bothriembryon bradshawi* sp. nov.**

Plate II., fig. 14.

A good series, collected by Mr. F. R. Bradshaw at Tambellup, north of the Stirling Ranges, and south of Broome Hill, provides an interesting problem.

The shell is small, thin, spire and mouth about equal in length, spire conical, mouth a little inflated so that it appears somewhat intermediate between the *kingii* and *melo* series.

The apex is a little more elevated than in the *melo* form, but not so elate as in the *kingii* group, and is finely punctate, the sculpture fading away so that no varix-like division is seen. The adult sculpture consists of fine sloping radials being more rude as the shell develops, and continuing on to the base of the last whorl. On the first adult whorl a few widely spaced concentric lines are seen which soon vanish. The early coloration is whitish mottled with reddish brown, the mottlings massing so that the coloration of the last whorl resembles that of some of the well-colored forms of *kingii*.

Length, 19.5 mm., breadth, 12 mm.

***Bothriembryon irvineanus* sp. nov.**

Plate II., fig. 15.

A series, collected by Mrs. Irvine, a very well-known West Australian shell lover, at Cape Naturaliste, along with *B. naturalistarum*, but probably occupying a distinct station ecologically, is here named.

The shell is thin, elongate, of the *melo* form, but narrower and showing no perforation, recalling *serpentinus*, but broader, the spire a little shorter than the aperture, columella twisted. Coloration uniform with no red circumbilical patch. The apex is coarsely punctate recalling that of *kingii*, but broader, more elevated than that of *bulla*; adult whorl strongly rudely radially ribbed crossed by concentric ditches producing a strong subnodulose effect, the radials persisting strongly on to the body whorl but concentric ditches disappear on base. Length of type, 26 mm.; breadth, 16 mm.

***Bothriembryon richeanus* sp. nov.**

Plate II., fig. 16.

A series labelled "Cape Riche, King George's Sound, S.W. Australia" by Brazier, proves that the locality "King George's Sound" was used for the whole of that south-west block, as Cape Riche is sixty miles distant, and is a well known landmark.

The shells are quite distinct, being strongly granulose recalling *leeuwinensis* and *brazieri*, but are narrower than the former, and broader than the latter. They belong to the *kingii* series, but are broader with the

spire not attenuate and about the length of the aperture. The apical whorls are strongly punctate, the adult whorls rounded, the sculpture being rather strongly nodulose, the nodules irregular, but squarish, and persisting but weakening on to the base of the body whorl. The shell is thin and consequently the outer lip is thin, the columella reflected, leaving so minute a chink that the shell appears imperforate. The coloration is a dirty fawn with indistinct longitudinal streakings of dull red; the red circumbilical patch is only seen in one specimen. The type measures 24 mm. in length, 13 mm. in breadth, the aperture 12 mm.

**Bothriembryon leeuwinensis** Smith 1894.

Plate II., figs. 17 and 18.

1894—*Bulimus* (*Liparus*) *leeuwinensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 94, pl. VII., fig. 27, June; Cape Leeuwin, South-West Australia.

1900—*Bothriembryon leeuwinensis* Pilsby, Man. Conch. (Tryon), Ser. 2, Vol. XIII., p. 13, pl. 3, fig. 49, Apl. 23.

1901—*Bothriembryon leeuwinensis* Kobelt, Syst. Conch. Cab. (Mart & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXV., lief 463, p. 768, pl. 112, fig. 4 (sheet dated 8 VII. 1901).

Smith's comparison reads: "*B. melo* is a broader and more bulky species, and *B. kingii* is more acuminate above, less granular, and exhibits more coloration both externally and within the aperture. The umbilicus is more closed than in the present species, and is surrounded by a brown zone." The notable feature is the strong granulation and this appears to connect it with the *kingii* series. Mr. A. W. B. Powell, of the Auckland Museum, has given me three specimens collected at Flinder's Bay by Clement L. Wragge, and these are topotypes of the species. The apical features prove it to be referable to the *kingii* series from which at sight it appears very different. The shell is elongate, rather stout, the spire about equal to the aperture, but not attenuate, the whorls appreciably shouldered. The apex is elevated, finely punctate, the punctations separable until the end of two whorls, where a definite small varix can be seen. The adult sculpture consists of coarse granulation, rough separate radials being cut into oblong lozenges by concentric deep irregular lines, the unevenness of the radials giving a nodulose suggestion. This continues on to the upper half of the last whorl, the rough radials alone being observed on the lower half. The columella is white, reflected, but leaving a notable umbilical chink behind; a white glaze connects the inner lip with the outer lip which is thin. The coloration is a uniform creamy white.

The length of the figured shell is 29 mm., the breadth 15 mm. A specimen from Lake Cave, Margaret River, generally agrees but is much narrower, measuring 28 mm. by 13 mm.

Another series from Margaret River is short and broad, recalling the *melo* series, but the apex seems to belong to the *kingii* series. The mouth and aperture are about equal, and the sculpture is similar to that of the above, but much weaker, the concentric lines disappearing on the body whorl. The columella is reflected but leaves an open chink, and the outer lip is thin. The coloration is dirty white with flesh streaks. There appears to be much confusion in the area from Cape Leeuwin to Cape Naturaliste, and for the present this form is being only named subspecifically ***Bothriembryon leeuwinensis eventus*** subsp. nov.; the type measuring 23 mm. in length by 14 mm. in breadth.

**Bothriembryon costulatus** Lamarek 1822.

Plate II., fig. 19.

- 1822—*Helix costulata* Lamarek, Hist. Anim. s. Vert., Vol. VI., pt. 2, p. 122, Apl. as synonym of *inflatus* infra, ex "Daubeb, No. 405," which refers to
- 1821—*Helix (Cochlogena) costulata* Férussac, Tabl. Syst. Anim. Moll. Limaçons, p. 58, Jan.; p. 54, June. Nomen nudum. "Le port du Roi George, dans la Nouvelle-Hollande, Péron: la baie des Chiens-Marins, Gaudicho."
- Shark Bay is here selected as type locality.
- 1822—*Bulimus inflatus* Lamarek, Hist. Anim. s. Vert., Vol. VI., pt. 2, p. 122, Apl. Nouvelle Hollande.
- Not *Bulimus inflatus* Olivier, Voy. Othoman, Vol. II., p. 356, 1801.
- 1838—*Bulimus costulatus* Potiez et Michaud, Galerie des Mollusques Mus. Douai, Vol. I., p. 138, pl. XII., figs. 17-18, October, ex *Cochlogena costulata* Férussac.
- 1841—*Bulimus inflatus* Delessert, Recueil Coq. Lamarek, pl. 28, fig. 1. Lamarek's shell figured.
- 1864—*Bulimus onslowi* Cox, Cat. Austr. Land Shells, p. 24. Dirk Hartog I., West Australia (Onslow).
- Figs. Cox, Mon. Austr. Land Shells, p. 74, pl. XIII., f. 13, May, 1868.
- 1892—*Liparus onslowi* Hedley, Rec. Austr. Mus., Vol. II., 29, Aug.
- 1894—*Bulimus (Liparus) onslowi* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 95, pl. VII., fig. 28 (not fig. 29), June. Dirk Hartog Island, West Australia (J. J. Walker).
- 1900—*Bothriembryon onslowi* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 11, pl. IV., figs. 43, 44, 48; Apex, pl. IV., fig. 75, Apl. 23.
- 1901—*Bothriembryon onslowi* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, lief 463, p. 769, pl. 112, fig. 15-16, (p. 765 dated 8 VII. 1901).

The identity of Lamarek's species seems to be obvious though hitherto overlooked. His description reads: "B. testâ ovatâ, ventricosâ, perforatâ, longitudinaliter striatâ, squalide albâ; spira obtusiusculâ; labro margine subreflexo. Habite dans la Nouvelle Hollande. Mon cabinet. Longueur, près d'un ponce."

This agrees very well with the Shark Bay shell, the words "ventricosâ . . . squalide albâ . . . spira obtusiuscula" being characteristic of that form. Férussac had previously named the shell *costulatus*, and Lamarek rejected this, renaming it *inflatus*, but unfortunately the latter had been previously used by Olivier, so that Férussac's name comes into use. As localities Férussac gave King George's Sound and Sharks Bay, and though the former locality has been accepted for Lamarek's *inflatus*, the figure given by Delessert is of the Shark Bay shell. This figure measures 27 mm. by 17 mm., and Shark Bay shells vary from 26 to 28 mm. by 17 mm., smaller ones 24 mm. by 16 mm., and 21 mm. by 15 mm. Smith's figure of *onslowi* measures 24 mm. by 16 mm., and Cox's measurements of *onslowi* are equal to 21.2 mm. by 15 mm.

Péron records from Bernier (and other) island(s) in Shark Bay: "Two species of land shells extremely numerous, but all dead, occupied great

stretches of the interior of the island; one was a small species of *Helix*, the other belonged to the genus *Bulimus* of M. de Lamarek." Férussac gave as the collector of his Shark Bay shells, "Gandieho"; this refers to C. Gaudichaud, the apothecary on the *Uranie*, which visited Shark Bay in 1818.

In further confirmation, Potiez and Michaud are cited, as they figured the Shark Bay shell under the name *Bulimus costulatus* Férussac, and acknowledged the assistance of Férussac.

The shell is roundly oval, the spire short, obtuse, less in length than the aperture, which is oval, outer lip thin, rather solid. The coloration of all the dead shells seen is white, but the living shell is orange, longitudinally flamed with dull streaks.

Apex flattened not distinguished finally from adult whorls, the sculpture beginning as faint wrinkled lines, the succeeding whorls sculptured with fine concentric lines cutting the faint growth lines into small lozenges which vanish below the periphery of the last whorl. Columella short, reflected triangularly over the umbilicus, which however is not closed.

### ***Bothriembryon minor* Pilsbry 1900.**

Plate II., fig. 20.

1900—*Bothriembryon onslowi* var. *minor* Pilsbry, Man. Conch. (Tryon), 2nd Ser., Vol. XIII., p. 12, Pl. 23, for Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 95, pl. VII., fig. 29, June. Dirk Hartog I., West Australia (J. J. Walker).

1901—*Bothriembryon melo* var. *hartogensis* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. 13, Theil 2, p. 770, pl. 112, fig. 15, dated June 19. Dirk Hartog's I., W.A.

Smith wrote: "*onslowi* . . . . Five other examples are considerably smaller, averaging only 15 to 18 mm. in length. They are a trifle less globose, and more strongly granular just below the suture." Pilsbry commented: "Apparently adult specimens of this small form before me are even smaller than the dimensions given by M. Smith, two measuring: Alt. 13.5 diam. 9, longest axis of aperture 8 mill, whorls  $4\frac{1}{2}$ ; and alt. 14.5, diam. 8.2, longest axis of aperture 8 mill., whorls a trifle over 5. They are strongly granose below the suture, and striped longitudinally with pale reddish or grey and opaque white." Kobelt later also named this form, and it seems common and easily separable and not a dwarf of "*onslowi*." Collecting might solve the problem as there is no similar instance of dwarfing in this family.

### ***Bothriembryon whitleyi* sp. nov.**

Plate II., fig. 21.

A nice series, collected by my colleague, Mr. G. P. Whitley, at Geraldton, is composed of white dead shells. They are, however, quite fresh and do not appear to have been coloured. Shell small, dead white rather shining subglobose perforate, perforation hidden by reflected columella. Apex of two whorls, finely punctate, a subvarix separating these from the adult four whorls which are longitudinally radially wrinkled, the radials crossed by concentric lines, which produce a subnodulose appearance, the base of the last whorl smooth. The mouth is oval, the outer lip thin, the columella rather broadly reflected, hiding the umbilicus, but leaving it quite open. Height 16 mm., breadth 12.5 mm. This is a plumper shell than *minor*, and differs in coloration.

**Bothriembryon perobesus** sp. nov.

Plate II., fig. 22.

One specimen from the mouth of the Moore River obviously belongs to the "*onslowi*" series, but is even more globose than the most inflated typical "*onslowi*." It is a live shell, and has the same style of coloration as the *onslowi* forms, but in the living shell the ground colour is pale yellowish green, the longitudinal banding a rich brown. The shell is stout, the spire very short and somewhat flattened, the body whorl taking up the bulk of the shell which consists of four adult whorls and two apical whorls, the latter being somewhat strongly eroded. The columella is broad, white, strongly reflected, hiding the narrow umbilicus, which, however, still remains open. Only a slight subeucellate sculpture appears below the suture, the shell otherwise being smooth, the growth lines scarcely showing up. The height of the shell is 25 mm. while its breadth is 19 mm. the length of the aperture being 15 mm., its breadth 8 mm. The annual rainfall is between 15 and 20 inches.

**Bothriembryon indutus** Menke 1843.

Plate II., fig. 23.

1842—*Bulimus indutus* Menke, Moll. Nov. Holl. Spec., p. 6, Apl. Darling Range and Mt. Eliza, West Australia.

Fig'd. Cox, Mon. Austr. Land Shells, p. 73, pl. 13, fig. 10, May, 1868.

Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 13, pl. 3, figs. 58-61, Apl. 23, 1900. Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXVIII., lief. 467, p. 783, pl. 114, figs. 2, 3, 7, sheet dated 28-XII.-1907.

1877—*Bulimus ponsonbii* Angas, Proc. Zool. Soc. (Lond.,) 1877, p. 70, pl. xxvi., fig. 1. Western Australia (J. Gould).

1901—*Panda* ? *ponsonbii* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXVIII., lief. 467, p. 785, pl. 114, fig. 5, sheet dated 28-VII.-1901. Angas, figure copied.

Although this species is one of the most distinct it was overlooked for some time but is now well known from its form and coloring as well as size. Two notable colour variations occur dull greenish yellow with dark growth period stop marks, and reddish brown with pale yellow growth period stop marks. Apparently these shells stop growth, and the inside of the outer lip takes on a different colouring, and when the shell restarts, it leaves a very distinct contrasting record of the stoppage. The shell is very elongate, stout, regularly narrowed about twice as long as broad, and while the columella is twisted a slight umbilical chink is present, the spire about equalling the aperture in length. The apex is punctate but usually eroded, and no varix can be seen, the adult whorls show a faint nodulose reticulation on upper whorls, the last whorl only with obscure growth marks.

The specimen figured is from King's Park, Perth, and measures 40 mm. in length by 19 mm. in breadth, while smaller ones measure 34 mm. by 16 mm. The dead shells are white as the coloration lies in the rather thick periostracum which clothes the shell.

Hedley (Proc. Malac. Soc. (Lond.), Vol. I, p. 260, 1895), wrote: "Judging from the figure of *Bulimus Ponsonbii*, and from the travels of its collector, I am disposed to deny that it is a *Liparus*, or that it comes from Western Australia, but hold it rather to be a variety of *Panda atomata* collected in New South Wales." There is now little doubt that Gilbert collected the specimens in the neighbourhood of Perth, and that the name is an absolute synonym of *indutus*.



**Bothriembryon glauerti** sp. nov.

Plate II., fig. 24.

A very distinct form belonging to the *indutus* series, but easily distinguished by its shape, the very short spire and the swollen body whorl, which is more than two-thirds the bulk of the shell. There is a glossy green periostracum which shows the characteristic "*indutus*" growth stages in darker relief. The apex is elevated, and the incurved earliest portion is coarsely anastomosingly wrinkled, a coarse irregular pitting succeeding, with finally a fine wrinkling striae forming; with a strong lens this sculpture can be traced on the body whorl, and more notably on the earlier whorls, subsutural wrinkling being present. The columella is twisted, white, a white glaze crossing the body whorl, the aperture within being bluish white, the outer lip thin; there is no umbilical fissure left, the shell appearing imperforate though in the very juvenile stage a small chink may be noted. The type measures 38 mm. in length by 22 mm. in breadth, the length of the body whorl being 30 mm. and that of the aperture 21 mm. The locality is Stirling Ranges, which is included in the 20 to 25 inches annual rainfall belt.

**Bothriembryon fuscus** Thiele 1930.

Plate II., fig. 25.

1930—*Bothriembryon fuscus* Thiele, die Fauna Süd-West Australiens, Bd.

V., lief 8, p. 588, pl. IV., fig. 68. Torbay, South-West Australia.

Thiele described a very immature specimen which appears to be a representative of a very large series collected by Mr. Sidney W. Jackson many years ago in the karri forests at Normalup Inlet, Deep River, which has a rainfall of 35 to 40 inches annually, which is the same as at Torbay. The Denmark shells are here described, and if these should be later proven distinct, as Thiele's figure is not exactly agreeable they may be called *franki* suggested by Mr. Jackson.

Shell large, elongate, narrow, spire and aperture about equal, latter oval, columella slightly thickened, appressed, commonly closing umbilicus, but very rarely this may be retained as a chink. Coloration varying from straw to dark brownish yellow, streaked with darker brown, especially along the growth lines. Sometimes the juveniles are uniform straw, at others dark chocolate; again shells may be found bearing a broad dark band above the periphery, a form of coloration seen in the shells from the Recherche Archipelago, forms of *rhodostomus*. When the shell rests the outer lip edge is darkened and this provides the dark growth streaking, a feature of all the *indutus* series. The apex is elevated, minutely wrinkling sculptured, the wrinkles fading into growth ridges, the whorls showing no distinct separation but succeeded by a fine concentric lining which never becomes prominent and soon disappears. The growth lines are flattened so that they are more notable as colour streaks than ridges, and the faint concentric lines can only be seen with a lens, the body whorl appearing smooth. Length (type of *franki*) 40 mm., breadth 21 mm., length of aperture 20 mm. These shells are found in hazel scrub up high on hazel trees and leaves, up to 40 feet on the limbs.

**Bothriembryon kingii** Gray 1825.

Plate II., figs. 26-28.

1825—*Bulimus kingii* Gray, Annals Philos (Thomson), Vol. XXV., (2 Ser., Vol. IX.), p. 414, June. New Holland (Capt. King) = King George's Sound, South-West Australia.

- 1826—*Helix bulimus* King, Narr. Surv. Coasts Austr., Vol. I., p. 12, "1827"  
= Apl. 15, 1826. Near Bald Head, King George's Sound.
- 1828—*Helix kingii* Wood, Suppl. Index Test, p. 22, pl. 7, *Helix*, fig. 27,  
(pref. May 17), New Holland. Brit. Mus. Type figured.
- 1822—*Helix trilineata* Quoy & Gaimard, Voy. Astrol., Zool., Vol. II., p. 107,  
pl. IX., figs. 1-3. Bald Head, King George's Sound, S.W.A.
- 1848—*Bulimus trilineatus* Reeve, Conch. Icon., Vol. V., pl. XLVIII, sp. &  
f. 310, November, as of Q. & G. New Holland.
- 1849—*Bulimus trilineatus* Reeve, Conch. Icon., Vol. V., pl. LIX., sp. & f. 397,  
January, ex Q. & G. "Port George," New Holland.
- 1864—(*Bulimus*) *quoyi* Cox, Cat. Austr. Land Shells, p. 23, new name for  
Reeve's fig. 397, not Reeve's fig. 310.
- 1868—*Bulimus kingi* Cox, Mon. Austr. Land Shells, p. 75, pl. XIII., fig. 7,  
May.
- 1892—*Liparus kingi* & var. *trilineatus* Hedley, Rec. Austr. Mus., Vol. II.,  
p. 29, Aug.
- 1900—*Bothriembryon kingii* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol.  
XIII., p. 7, pl. 2, figs. 21-28, apex, pl. 4, fig. 77-78, Apl. 23.
- 1900—*Bothriembryon physoides* var. *humilis* Pilsbry, Man. Conch. (Tryon),  
Ser. II., Vol. XIII., p. 10, pl. II., figs. 33-34, Apl. 23. King  
George's Sound, West Australia.
- 1901—*Bothriembryon trilineatus* Kobelt, Syst. Conch. Cab. (Mart. &  
Chemm.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXV., lief.  
463, p. 766, pl. 112, figs. 5-9, (sheet dated 8, VII., 1901).
- 1901—*Bothriembryon kingii* Kobelt, id. ib., heft CLXVIII., lief. 467, p. 779,  
pl. 113, figs. 19-23, pl. 116, figs. 14-15, (sheet dated 10 VII., 1901).
- 1901—*Bothriembryon physoides* var. *humilis* Kobelt, id. ib., p. 790, pl. 116,  
figs. 9-10, (sheet dated 2 VII., 1901).

The typical *kingii* shows the attenuate form of this group, though the shell was only half grown; a little later Quoy and Gaimard gave excellent figures of the shell and animal from exactly the same place as King had collected them. Their shell was fully grown, and less boldly marked, and both names have sometimes been used but the latter name is absolutely synonymous. Unfortunately the general locality, King George's Sound, was used for shells from the surrounding area where more than one race may occur. Hence Pilsbry named a var. *humilis* of *physoides*, which is based on a small local series of the present species, but the name can not be used, as no definite locality is known, and the shells appear immature.

The shell is elongate, the spire acuminate, the apex elevated, the mouth elongate, shorter than the spire, the columella reflected and appressed with a twist, obliterating the umbilicus, outer lip thin. The shell is thin and delicate, and the coloring is a dirty white streaked more or less thickly with pale brown, rarely of a reddish tinge. The streaks are commonly notable as in the type of *kingii*, and are as commonly almost obsolete as in the type of *trilineatus*. Some are almost clear white, others clear yellowish, and in some cases the streaks coalesce, and an almost uniform brown body whorl is formed. The thinness and shape are however constant as is the lack of any defined sculpture, the rude flattened radials showing no cross sculpture. The apex consists of two whorls, the tip elevated, minutely punctate, the punctations finally running into lines: the adult whorls follow without a varix, but the

change can be seen. The columella is reflected, closing the umbilicus as a general rule, but in some cases as in *trilineatus* typical, as here shown, the swelling of the body whorl allows the retention of a slight chink indicating that the juvenile is perforate. A circumbilical red patch is usually present in this group. The two specimens figured are from the type locality, and represent normal *kingii* and *trilineatus*, the former measuring 24 mm. in length, by 13 mm. in breadth, the latter being 29 mm. in length, by 15 mm. in breadth.

The type of Pilsbry's var. *humilis* is also here figured, and it measures 17.5 mm. in length, by 10 mm. in breadth. It is obviously referable to this series, but differs from the typical form in showing a coarser longitudinal radial ribbing, cut by a few concentric lines on the earlier whorls and on the shoulder of the last whorl. There is an umbilical chink, and no red circumbilical patch, and somewhat similar shells have been seen from the Pallinup River, South Coast.

***Bothriembryon notatus* sp. nov.**

Plate II., fig. 29.

An excellent series from the Pallinup River, south coast, recalls *B. jacksoni*, but the shells are narrower and have a paler ground colour. Shell thin, elongate, of the *kingii* style, but the spire not so attenuate, and the mouth is equal to the spire in length. Coloration greyish-white longitudinally flamed with red brown, the markings varying in intensity, some showing few marks being almost unicolor, while others have the markings running together so as to produce an almost uniform dark shell. The red circumbilical patch is always present. The apex is of the typical *kingii* form, the succeeding whorls sculptured with wide longitudinal ribbing, which is most pronounced below the suture producing a puckered collar. This persists on to the body whorl, where otherwise the ribbing becomes obsolete. The columella is reflected so as to hide the umbilicus, which, however, remains open as a chink. Length 24 mm., breadth 11 mm., length of aperture 12 mm.

***Bothriembryon jacksoni* sp. nov.**

Plate II., fig. 30.

A very interesting form of the *kingii* series was collected by Mr. Sidney W. Jackson at Deep River, Frankland River, Nornalup, to the west of King George Sound, on trees and shrubs in the hazel scrub among the karri.

It lacks the acuminate spire having a rather swollen body whorl with a conical short spire, the texture thin, the colouring bright fawn with deep red brown streaks, and a deep red brown circumbilical patch. The apex is finely regularly punctate throughout the two whorls, the sculpture on the subsequent whorls being composed of rude radials crossed lightly on the earlier whorls by fine concentric lines forming a fine nodulation at places, but irregular and becoming obsolete on the body whorl. The columella is twisted, white, and reflected leaving an umbilical chink. The length of the type is 27 mm., the breadth 15 mm., length of spire 13 mm.

***Bothriembryon maxwelli* Kobelt 1901.**

Plate II., fig. 31.

1901—"Bothriembryon" *maxwelli* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2. heft CLXVIII., lief 467, p. 781, pl. 112, figs. 4, 5, 17, sheet dated 28 VII. 1901, ex Brazier M.S. No definite locality = "Doubtful Island King George's Sound, W.A."

1868—*Bulinus kingi* Cox, Mon. Austr. Land Shells, p. 75, pl. 19, fig. 12, 12a, May. Doubtful l., W. Australia (Masters).

1900—*Bothriembryon kingii* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., pl. 2, fig. 29 only, Apl. 23.

Although Cox figured this form he did not mention it in the text, and Pilsbry also figured a specimen which is here refigured, and then Kobelt brought in a Brazier MS. name for this shell. There are many specimens in the Australian Museum bearing Brazier's MS. name, and localised as Doubtful Island, but which Doubtful l. is intended must be found out by local collectors. On the labels here it is said to be "Doubtful Island, King George's Sound," and many shells of the *melo* series are also so labelled, one set being the *castaneus* form (Pilsbry's fig. 18), and another set agreeing with Pilsbry's figure 3. If there be three distinct series of *Bothriembryon* living on Doubtful Island, the place is in need of close investigation. The shell is a small thin representative of the *kingii* form, but is smaller, narrower and not so attenuate as the typical shell. It is always of a fawn colour, rarely streaked with reddish and the red circumbilical patch is usually absent. The apex is elevated, normally punctate, the punctations linking up into lines, the adult sculpture easily separated, rough radial ribbing developing below the suture where it persists through growth. The radials become obsolete with age, while a regular series of concentric lines appears on the earlier whorls, none of which cuts the radials. The columella is appressed, almost closing the umbilicus, but generally a chink remains. The length of the figured specimen is 20 mm. with a breadth of 10 mm.

Recent research suggests that this Doubtful Island is the island off Doubtful Island Bay, and this is confirmed by the name *marwelli* as there is a Mt. Maxwell overlooking that bay.

### ***Bothriembryon perditus* sp. nov.**

Plate II., fig. 32.

Specimens collected by E. Gratwick, 70 miles east of Israelite Bay, that is, some twenty miles east of the type locality of *gratwicki*, are all dead, but show remains of the colour pattern, which is that of the *kingii* series. The shape is elegant, the body whorl not swollen, but the aperture about equal to the spire, the texture thin, the spire is not acminate. The coloration shows regular reddish flame streaks on a whitish ground, some however nearly unicolor. Apex elevated, punctate, the succeeding sculpture regular wavy growth lines with transverse cross lining but the whole sculpture very weak: the puckering below the suture is well marked and a little of the longitudinal radials remains on the body whorl. Columella twisted and appressed so that no umbilical fissure remains, the shell appearing imperforate. A thin glaze crosses from the inner lip to the edge of the outer which is thin. Length of type 24 mm., breadth 12 mm.

The locality is in the annual rainfall 15-20 inches belt.

### ***Bothriembryon sayi* Pfeiffer 1847.**

Plate II., figs. 33 and 34.

1847—*Bulinus sayi* Pfeiffer, Proc. Zool. Soc. (Lond.), 1846, p. 114, Jan. 26, 1847. Locality unknown = Cape Freycinet, West Australia. Fig'd Reeve, Conch. Icon., Vol. V., pl. LXV., sp. and fig. 458, 1849.

1900—*Bothriembryon kingii* var. *solidus* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 9, pl. II., fig. 28, April 23. West Australia = Margaret River.

Specimens from Cape Freycinet agree so closely in their features with the figure and description of *sayi* that they can be so named, while *solidus* Pilsbry appears to be merely a large local variation of this species.

The typical shell is small, with an attenuate spire with the whorls flattened, rather solid, with the umbilicus always left a little open. The coloration is whitish with a few pale red streaks at times. There is no circumbilical patch in this series, other wise there is no discrepancy at all. A rather notable feature is the thickening of the columella and the strong white glaze connecting the inner and outer lips, the latter having the edge stouter than usual.

The type of *solidus*, here figured, is much larger and more solid, and belongs to a series from the Margaret River, having the same conical attenuate spire with flattened whorls, and the longitudinal sculpture a little stronger.

### ***Bothriembryon naturalistarum* Kobelt 1901.**

Plate II., figs. 35 and 36.

1901—*Bothriembryon kingii* var. *naturalistarum* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, hft CLXVIII., lief. 467, p. 781, pl. 113, figs. 22-3, sheet dated 28-VII-1901. Cape Naturaliste, West Australia.

1900—*Bothriembryon kingii* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 9, pl. 2, fig. 30 only, Apl. 23. Cape Naturaliste, W.A.

Pilsbry wrote: "Fig. 30 is a small specimen from Cape Naturalist. There are 5 whorls, the last inflated below, almost imperforate. It is beautifully streaked with opaque, glossy white on a corneous and purplish brown ground. Alt. 20, diam. 11, longest axis of aperture 10, 7 mill. The aperture is decidedly more oblique than in the typical form from King George Sound. It is not unlikely that this will prove a geographic race or variety. From the Cox collection." Kobelt gave this the varietal name *naturalistarum*. The series from which Pilsbry selected the figured shell is before me, and I am refiguring his specimen. Again it is immature, but numbers collected by Tom Carter at the same locality show that it develops into an elongate shell very like that from Margaret River, which I regard as *sayi*, but it is thin and has the mouth more expanded, is smooth, and measures 25 mm. in length by 13 mm. in breadth.

Local naturalists must study these shells and fix the status of the named forms.

### ***Bothriembryon revectus* sp. nov.**

Plate II., fig. 37.

While collecting numerously *B. jacksoni* at Deep River and Bow River, Mr. Sydney W. Jackson also found alive under debris on ground in dense hazel scrub at the Bow River some shells of the *kingii* series, but sculptured after the style of *brazieri* and *leenwinensis*. The narrow shell here selected as type measures 23 mm. in length by 11 mm. in breadth; a broader shell measures 23.5 mm. in length by 12.5 mm. in breadth. The spire about equals the aperture in length, and is not attenuate. The columella is appressed so that barely a chink remains, and there is a red circumbilical patch, while the

apex is of the *kingii* style. The sculpture is subnodulose, the radials irregular and rather ill-defined, while the concentric lines vary in strength, but the sculpture is notable in every case. The coloration is fawn, more or less flamed with red brown, the shell thin and the surface lustreless.

A similar shell was found on small bushes "in jarrah forest, Mt. Frankland," three months later by Jackson.

Smith's record of *physoides* (Proc. Malac. Soc. (Lond.), Vol. I., p. 95, pl. VII., figs. 30-31, June, 1894) may refer to shells of this form.

### **Bothriembryon brazieri** Angas 1871.

Plate II., fig. 38.

1871—*Bulinus* (*Liparus*) *brazieri* Angas, Proc. Zool. Soc. (Lond.), 1871, p. 19, pl. I., fig. 28, June 12. Sinclair's (error for Stirling) Range, King George's Sound, West Australia.

1873—*Bulinus* (*Liparus*) *brazieri* Brazier, Proc. Zool. Soc. (Lond.), 1872, p. 807, correction of error of locality name.

1892—*Liparus brazieri* Hedley, Rec. Austr. Mus., Vol. II., p. 29, Aug.

1900—*Bothriembryon physoides* var. *brazieri* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XIII., p. 10, pl. 2, figs. 38-40, Apl. 23.

1901—*Bothriembryon brazieri* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXVIII., bef. 467, p. 778, pl. 113, figs. 17-18. (sheet dated 10, VII, 1901).

This extraordinary development of the *kingii* series is shorter than usual, not so acuminate in the spire, the whorls more rounded. The coloration is a brownish fawn with a few red radial streaks and a bright red circumbilical patch. The sculpture is coarsely granular, the rude longitudinal ribs being cut into nodules by deep concentric lines, and this sculpture continues on to the base of the body whorl. The apex is of the *kingii* style, finely punctate and stopping abruptly at the end of two whorls. The columella is white, appressed leaving a small chink. The shell is thin, and the figured one measures 19 mm. in length by 10 mm. in breadth.

### **Bothriembryon gratwicki** Cox 1899.

Plate II., fig. 39.

1899—*Bulinus gratwicki* Cox, Proc. Linn. Soc., N.S.W., Vol. XXIV., p. 435, fig. in text, December 9. 50 miles East of Israelite Bay, South-West Australia.

1900—*Bothriembryon gratwicki* Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. XIII., p. 11, pl. 2, figs. 31, 32, pl. 45, figs. 2-4, Apl. 23.

1901—*Bothriembryon gratwicki* Kobelt, Syst. Conch. Cab., (Mart & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXVIII., bef. 467, p. 789, pl. 116, fig. 718, (sheet dated 2, VIII, 1901).

This interesting shell is elongated, narrow, spire long, pointed, longer than aperture, which is narrowly oval, solid, chalky, umbilicate. The coloration is chalky white. Strongly sculptured throughout, thereby differentiating this species from all others save *brazieri*. The sculpture consists of elevated irregular rounded ribs, apparently intensified growth lines, over-run with concentric lines forming a subnodulose ornament, the nodules irregular in size and form.

The apex is coarsely wrinkly striate around the upper part of the whorls, the lower reticulately pitted, consisting of two full whorls, the adult sculpture abruptly forming thereafter, almost a varix intervening.

The columella is strongly reflected, but does not hide the umbilicus, and joins the outer lip, which is thin, by means of a glaze across the body whorl, almost freeing the mouth.

Length of figured shell, 27 mm.; breadth 12 mm.

The locality is in the annual rainfall 10-15 inches belt.

### **Bothriembryon dux** Pfeiffer 1861.

Plate II., fig. 40.

1861—*Bulimus dux* Pfeiffer, Proc. Zool. Soc. (Lond.), 1861, p. 24, May 1. King George's Sound, South-West Australia. Fig'd. Cox, Mon. Austr. Land Shells, p. 71, pl. XIII., fig. 4, pl. XVIII., fig. 16, May, 1868.

1892—*Liparus dux* Hedley, Rec. Austr. Mus. Vol. II., p. 29, August.

1894—*Bulimus (Liparus) dux* Smith, Proc. Malac. Soc. (Lond.), Vol. 1, p. 91, June.

1900—*Bothriembryon dux* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 3, pl. 3, fig. 62, Apl. 23.

1901—*Bothriembryon dux* Kobelt, Syst. Conch. Cab., (Mart & Chemn.), ed. Kuster, Bd. I., Theil 2, heft CLXV., lief. 463, p. 763, pl. 112, figs. 1-2, sheet dated 21 : VI. : 1901.

This magnificent species stands alone in its large size, its white colour, and its solidity. The apex is regularly punctate, the sculpture is of rough radials crossed on the earlier whorls by fine concentric lines, the cross sculpture vanishing on the shoulder of the last whorl. The columella is broadly reflected, concealing an open umbilicus, and the outer lip is thin. The spire is about the same length as the aperture. The shell figured measures 60 mm. in length by 35 mm. in breadth. Odd specimens are known from Norseman, Dundas, Salmon Gums, Balladonia, Esperance Mallee Belt, and it thus seems to be an inhabitant of the drier inland belt and not coastal although all the early collected specimens are labelled King George's Sound.

### **Bothriembryon barretti** Iredale 1930.

Plate II., figs. 41 and 42.

1930—*Bothriembryon barretti* Iredale, Vict. Naturalist, Vol. XLVII., p. 119, fig. in text, Nov. Nullarbor Plain, S.W. Australia.

1879—*Bulimus indutus* var. *pallidus* Tate, Trans. Proc. Roy. Soc. Adelaide, South Austr., 1878-9, p. 134. Bunda Plateau, Nullarbor Plain, South Australia.

Not *B. pallidus* C. B. Adams, Proc. Bost. Soc. Nat. Hist., Vol. II., p. 12, 1845.

1900—*Bothriembryon indutus* var. *pallidus* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. XIII., p. 15, pl. 3, figs. 63, 64, 65. Apl. 23.

1901—*Bothriembryon indutus* var. *pallidus* Kobelt, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Theil 2, heft CLXVIII., lief. 467, p. 784, pl. II4, fig. 8 (sheet dated 28-VII.-1901). Pilsbry's figures copied only.

The original description of *barretti* reads: "Shell elongate, dirty white, aperture about equal to length of spine (spire). The apex is sculptured with a curious fine wrinkling, which develops into fine radials which are later crossed by revolving lines. This causes a mat-like appearance of rather longitudinal nodules, which, however, disappear upon the base. A young example shows the spiral sculpture much more prominently than in the adult. There is an umbilical clink present, and the outer lip is sharp. Whorls, six; length, 27 mm.; breadth, 15.5 mm.

The type of *B. barretti* was collected near Hampton inside the Western Australian boundary. Tate's locality, "Bunda Plateau" also crosses the border line, and in a series sent to Pilsbry he figured two variations, the general label being "Eucla." Among the shells before me now there are also two varieties, and it is now seen that the coastal shells are narrower than the more inland ones. Upon referring to the rainfall again, that is given as being 20-25 inches on the coast, and only 15-20 inches in the inland area. The narrow form was figured by Pilsbry, f. 63, and his specimen is here refigured as type of a subspecies, *B. b. indictus* nov., the shell measuring 30 mm. in length by 15 mm. in width, the series coming from Eucla.

#### **Bothriembryon distinctus** sp. nov.

Plate II., fig. 43.

A series of shells from Cardanumbi, west of Eyre, is of great interest, the shells having an acuminate spire with a swollen body whorl. This shape is not seen in any other series, the *kingii* being elegantly slender, while the *melo* forms are regularly oval.

The coloration is dirty white in the dead shells examined. The apex is not elevated, wrinkled, the wrinkling being succeeded by a punctation, no subvarix visible, the adult sculpture being of the usual rough radials, somewhat subdued, and crossed by fine concentric lines, irregularly forming squarish nodules, which disappear altogether on the body whorl, only faintly discernible on the penultimate one, and never very strong on any of the earlier whorls. Although the umbilicus is open, the broadly reflected columella hides it, the mouth is rather large, the outer lip thin. The spire is longer than the aperture but the body whorl is large and dominant. The length of the type is 27 mm., breadth 15.5 mm., length of the aperture 12 mm., the breadth of the penultimate whorl 9 mm.

The locality is in the annual rainfall 10-15 inches belt, and from the 70-mile tank at Balladonia similar shells have been sent along with *barretti*.

As above stated, this species does not fit into any of the named subgeneric groups so is here differentiated as **Celatembryon** subgen. nov.

#### **FAMILY LAOMIDAE.**

Though this family name is continued, it may need revision as all the Australian forms have unarmed mouths, and a distinct shell appearance, the Neozelanic typical *Laoma* having teeth in the aperture, and a different shell texture. However our shells appear to be of Paralaomid alliance, and that is a Neozelanic group with suggested relationship to *Laoma*.

#### **Genus WESTRALAOMA** gen. nov.

Ordinary looking Paralaomids in general appearance, but with the protoconch concentrically spirally striate. The shells are small, generally under 3 mm. in breadth, and 1.50 mm. in height, depressedly conical with



comparatively large apical whorls, the apex, as above, concentrically spirally striate, the adult sculpture radial threads, with larger radial ridges, more or less distant, and usually well marked, rarely with concentric striation. The umbilicus is comparatively wide and open, the mouth circular, the lip thin. The type of *Westralaoma* is *W. experta* nov.

The true *Paralaoma* (Iredale Proc. Malac. Soc. (Lond.), Vol. X., p. 380, Sept., 1913) was based on a similar looking Kermadec shell, which has a smooth or radiately striate protoconch, and which lived in dry places, and the majority of Australian Paralaomids have the same habit.

***Westralaoma experta* sp. nov.**

Plate I., figs. 18 and 28.

1868—*Helix morti* Cox, Mon. Austr. Land Shells, p. 21, pl. XI., fig. 13, W. Australia.

1894—*Patula morti* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 87, June; above record only.

When Smith included this species on Cox's record, he noted "This is the only instance among the Australian Helices in which the same species occurs on both sides of the continent," as it had been described from Sydney. Once again geographical values prove more important than superficial association, as upon re-examination, the Westralian shells are seen to differ in the essential feature of the sculpture of the protoconch. The series so named by Cox is available and the species is named as above. Shell very small, subconical, narrowly umbilicate, brown. The apex is large, bulbous, of two whorls, spirally finely striate, adult whorls sculptured with distant radial ridges and fine striae, on the last whorl the strong radials number between thirty and forty, the interstices finely radially striate with a finer concentric striation, forming a subreticulation under a high power; the mouth is large, the outer lip thin. Breadth 1.25 mm.; height .5 mm. The type locality is King George's Sound, collected by Masters.

***Westralaoma scitula* sp. nov.**

Plate I., fig. 19.

This species, discovered by Mr. Sidney W. Jackson at the Bow River, South Coast, is somewhat depressed, the umbilicus open, deep, and about one-third of the basal breadth.

The apical whorls are finely concentrically striate without any varix, the adult sculpture being composed of fine radial striae, with about twenty to twenty-five developing into prominent ridges, about six to eight striae between each ridge. The whorls are convex, the last whorl subangulately rounded, but not keeled, the mouth open subcircular, lip thin, columella straight, a little reflected, not obscuring the umbilicus in any way.

Breadth 1.5 mm.; height .6 mm.

Found in Hazel and Karri scrub under debris on ground.

***Westralaoma expicta* sp. nov.**

Plate III., fig. 4.

A typical Paralaomid form with the apex elevated, superficially smooth but, with a strong power, concentric lining can be recognised: adult sculpture of the regular Paralaomid style, fine radials with distant coarse ridges about

twenty-five, the fine radials crossed by fine concentric threads suggesting a faint decussate which is faintly seen on base. The umbilicus narrow deep, about one-fourth the breadth of the base, the mouth descending, subcircular, outer lip thin, columella slanting, reflected. Breadth 1.5 mm; height 1 mm.

Nangeenan via Merredin, W.A., collected by E. Sedgwick.

**Westralaoma aprica** sp. nov.

Plate III., fig. 7.

A depressed Paralaomid form lacking strong radial ridges, and the fine radials are crossed by a subordinate concentric threading producing a finely decussate appearance which is more notable in the umbilical cavity, which is about one-third the breadth of the base. Shell subdiscoidal, spire little elevated, apex finely concentrically striate, mouth subcircular, outer lip thin, columella a little reflected. Breadth 2 mm.; height 1.1 mm.

Nangeenan via Merredin, W.A., collected by E. Sedgwick.

Genus **INSULLAOMA** Iredale 1937.

1937—*Insullaoma* Iredale, South Austr. Naturalist, Vol. XVIII., p. 19, Sept. 30. Haplotype *Paralaoma riddlei* Iredale.

This name was introduced subgenerically for the South Australian forms of *Paralaoma*, as these had the apical whorls spirally striate or even lirate, whereas the typical form had the apex smooth or radially finely striate. The shell selected as type of *Insullaoma, riddlei*, was somewhat elevated, umbilicus narrow, finely reticulately sculptured, and had the apex boldly strongly concentrically lined. Of course this cannot be seen without a strong lens. Moreover, in this case there was a peripheral subkeeling. The recognition of a Western Australian form agreeing in all these features has led to the admission of this group generically.

**Insullaoma predicta** sp. nov.

Plate I., fig. 22.

Another of the discoveries of Mr. Sidney W. Jackson at Bow River, South Coast, especially as it appears to be a true *Insullaoma*. Shell small, subdiscoidal, spire short, brown, umbilicus narrow. The apical two whorls are large and bulbous, and are coarsely spirally lirate: the adult whorls are closely fine radiate, with a fine concentric striation crossing it, the last whorl subkeeled. The mouth is subcircular, outer lip thin, columella a little reflected, the umbilicus open, narrow, less than one-third the width of the base. Breadth 1.25 mm.; height .6 mm.

Found alive under karri bark at foot of karri tree on edge of wattle scrub.

Genus **GRATILAOMA** gen. nov.

Type **G. cara** sp. nov.

Plate I., fig. 20.

This beautiful little shell collected by Mr. Sidney W. Jackson at the Bow River, South Coast, suggests an elevated relation of *Westralaoma*, as it is subconical with similar radials, but has a cross sculpture of crosslining, the umbilicus being narrowed.

As *Westralaoma* is constant in form it seems better to name the present form separately than refer it to that genus, and thus spoil the homogeneity of the group.

Shell very small, subconical, whorls a little rounded, sutures lightly impressed, last whorl descending rather rapidly, mouth subcircular, oblique, outer lip thin, columella rather broadly reflected, obscuring a little the narrow open deep umbilicus. Coloration pale brownish. Apex very finely concentrically striate, about two whorls, adult whorls three and a half, sculpture with fine growth striae and these are crossed by very obscure concentric striation. A few distant large striae develop but they can scarcely be called ridges; these number about twenty-five to thirty but they are irregularly spaced and never prominent. Breadth 1 mm.: height .8 mm.

Found alive under karri bark in dense wattle scrub.

#### FAMILY DIPNELICIDAE.

This family was introduced for an interesting shell from Hammock Island, South Australia, and it was remarked "It has not yet been discovered on the mainland, which suggests that it is a relict form of great age." Mr. Sidney W. Jackson collected, at the Bow River and Deep River, specimens of another curious shell, and though it differs in detail it seems to recall the South Australian shell in some respects. It apparently does not fit into any of the other families, such as Charopidae, Laonidae, Flammulinidae or Rhytididae.

Genus **ANNOSELIX** gen. nov.

Type **A. dolosa** sp. nov.

Plate I., figs. 24 and 27.

A very curious little shell, regularly broadly conical, the base convex, the periphery keeled, umbilicus deep, very narrow, the mouth squarish, the outer lip thin, columella.

Coloration brown, base paler brown, but sometimes flamed with reddish brown.

One apical whorl apparently smooth but obscurely radially striate, the striae developing on the adult whorls without any intervening varix. There are four and one-half adult whorls regularly increasing, whorls flattened, sutures scarcely impressed. The radial striae develop slowly and become very numerous and fine, while a delicate concentric striation also forms, producing a very fine semi-cancellate appearance. On the base the concentric spirals generally predominate. Breadth, 7.5 mm.: height 5 mm.

The type is from Deep River, and some specimens from Bow River, South Coast, show that, in some cases, the radials, every now and then, strengthen into ridges and create a fringe at the periphery and continue strongly on to the base. This fringe sticks out a little, and presents a saw-like appearance to the peripheral keel.

#### FAMILY CHAROPIDAE.

This family has a few members in Western Australia, but there may be many more, as they are minute and difficult to find. Seven species have been described and while one is rejected, a few are added. One eastern genus, *Pernagera*, based however on a western shell, is admitted, but the remainder of the species appear to be of endemic origin. All the species so far seen have no armature of the mouth, and all are openly umbilicate. The features of the family are the small size of the shell, the depressed helicoid form, commonly discoidal, with an adult sculpture of numerous radial ridges of varying strength.

Genus **PERNAGERA** Iredale 1933.

1933—*Pernagera* Iredale, Rec. Austr. Mus., Vol. XIX., p. 53, Aug. 2. Orthotype *Helix albanensis* Cox.

Shell small, somewhat elevated for this family with a very wide cavernous umbilicus, the radial sculpture being rather coarse. Whorls loosely coiled, sutures deep, almost canaliculate, apex radially striate, the tip smooth. The mouth is subcircular, outer lip thin, columella straight, scarcely reflected at all.

**Pernagera albanensis** Cox 1868.

Plate I., fig. 23.

1868—*Helix albanensis* Cox, Proc. Zool. Soc. (Lond.), 1867, p. 723, April 3. King George's Sound, West Australia (Masters). Fig'd. Cox, Mon. Austr. Land Shells, p. 15, pl. IV., fig. 2, May, 1868.

Shell small, almost subglobose, spire conical, whorls rounded, loosely coiled, almost separated by a canaliculate suture, the last whorl descending, other characters as for the genus. Coloration fawn, irregularly rayed with reddish. Apex tip smooth, then radiately striate, the striae developing into riblets which are numerous and fairly regularly spaced, about seventy-five on last whorl, the interstices finely radially striate, no concentric lines apparent. Umbilicus funnel shaped, about one-half the width of the shell. Breadth 5 mm.; height 3 mm.

**Pernagera lena** sp. nov.

Plate III., fig. 3.

A very pretty little shell, collected by Mr. Sidney W. Jackson at the Bow River, recalls *albanensis* in miniature. Shell small, subdepressed, spire slightly elevated, whorls rounded, sutures deep, almost canaliculate, last whorl descending a little, mouth subcircular, columella straight, scarcely reflected, umbilicus wide, funnel shaped exposing all the whorls. Coloration pale brownish with broad red flames. Apex smooth at tip, then finely radially striate, the striae developing into ridges which are regular and numerous, numbering about one hundred and twenty on the last whorl, the interstices striate. Umbilicus about half the width of the base of the shell. Breadth 3 mm.; height 1.5 mm. Under bark and leaves on the ground in Hazel scrub.

Genus **LUINODISCUS** Iredale 1937.

1937—*Luinodiscus* Iredale, Austr. Zool., Vol. VIII., p. 331, Feb. 12. Orthotype *Helix cuprea* Cox.

"Small flattened charopid shells, spire not sunken, umbilicus wide, mouth small, thin, sculpture of regular fine radials, protoconch spirally lirate." While the type of *Luinodiscus* is a small shell, other species, referred for the present to this group, are large and more bulky.

**Luinodiscus cupreus** Cox 1868.

Plate III., fig. 5.

1868—*Helix cuprea* Cox, Mon. Austr. Land Shells, p. 22, pl. XII., fig. 9, May. King George's Sound, West Australia (Masters, A. M.).

1875—*Helix* (*Charopa*) *nupera* Brazier, Proc. Linn. Soc., N.S.W., Vol. I., p. 18, Apl. 27. King George's Sound, W.A. (Masters).

Shell discoidal, spire not sunken, whorls rounded, sutures deeply impressed, last whorl descending a little, mouth subcircular, lip thin, columella not reflected, straight, umbilicus very wide. The apex is concentrically striate, the adult whorls closely finely ribbed, ribs about eighty in number, interstices striate. Coloration fawn. Breadth 2.5 mm.; height 1.5 mm.

***Luinodiscus sublestus* Benson 1853.**

1853—*Helix sublesta* Benson, Ann. Mag. Nat. Hist., Ser. 2, Vol. VI., p. 30, Jan. 1. Fremantle, Swan River, West Australia.

Fig'd. Reeve, Conch. Icon., Vol. VI., pl. 174, sp. 1177, Oct. 1853.

Fig'd. Cox, Mon. Austr. Land Shells, p. 16, pl. XI., fig. 10, May, 1868.

1930—*Charopa hedleyi* Thiele, Die Fauna Südwest Austr., Bd. V., lief 8, p. 587, pl. IV., fig. 67. Brunswick.

Benson naturally gave no details as to the protoconch features nor the number of ribs. It was differentiated from "*H. Iuloidea*, Forbes, by its narrower umbilicus, and the want of concavity in the spire; from *H. cygnea* by the first mentioned feature, and the sculpture."

Thiele does not compare his new species with this, and generally there is agreement, the protoconch being described as spirally sculptured, its size being given at 3.75 mm. in breadth, 1.8 mm. in height, with the umbilicus 1 mm. wide.

Benson's description is here given as the species needs fixation: "Shell rather broadly umbilicate, orbiculate depressed, above red horny, below horny, very minutely costulately striate above, rather flattened, sutures impressed, whorls four, the last a little depressed, rounded, aperture vertical, roundly lirate, peristome acute, umbilicus perspective. Diam. major 3, minor  $2\frac{1}{2}$ , axis 1 mill."

Specimens from the Swan River, collected by R. Helms, measure up to 4 mm. in breadth by 2 mm. in height. These generally agree that the spire is flattened, but not depressed, the umbilicus wide, open, perspective, fully one-third the width of the base. The apex appears to be smooth but under a high power is seen to be finely concentrically striate, the adult sculpture of radial ridges shows between ninety and one hundred on the last whorl, the intestines being crossed by very fine concentric threads, only discernible by a high power.

Specimens from Peppermint Grove are consistently smaller but otherwise there appears to be no definable distinction.

***Luinodiscus cygneus* Benson 1853.**

Plate I., fig. 25.

1853—*Helix cygnea* Benson, Ann. Mag. Nat. Hist., Ser. 2, Vol. VI., p. 30, Jan. 1. Perth, Swan River, West Australia (Dr. J. F. Bacon).

Fig'd. Reeve, Conch. Icon., Vol. VII., pl. 174, sp. 1182, Oct. 1853.

Fig'd. Cox, Mon. Austr. Land Shells, p. 16, pl. 12, fig. 3, May, 1868.

1930—*Charopa cuprea* Thiele, Die Fauna Südwest Austr., Bd. V., lief 8, p. 587. Fremantle, S.W.A.

Not *Helix cuprea* Cox 1868 *ut supra*.

Contrariwise, Benson separated this from *H. sublesta* by the more distant ribs, wider umbilicus, colour and larger size from *H. Iuloidea*, Forbes, of the eastern coast of Australia, by its more distant ribs and want of concavity on the upper side. Diam. major 4, minor  $3\frac{1}{2}$ , axis  $1\frac{1}{2}$  mill.

Thiele, again, overlooking this species, referred specimens to *cuprea* with the size 3.75 mm. by 2 mm., the protoconch finely sculptured spirally, and the adult whorls decussate. The size and the sculpture refer the specimens to this species, rather than to *cuprea*. Benson's description is here offered for reference: "Shell broadly umbilicate, orbiculate depressed, horny, furnished with rather remote oblique costulate radials; spire scarcely a little convex, sutures excavate, apex planate; whorls four and one-half, convex, last rounded, aperture subvertical, roundly lunate, peristome acute, umbilicus perspective." Reeve figured the type specimen the same year, and added to the above description "decussated, beneath the lens, in the interstices with very minute spiral striae" and showed this character in his illustration.

***Luinodiscus repens* sp. nov.**

Plate I., fig. 21.

Another of Mr. Sidney W. Jackson's discoveries at the Bow River and Deep River, this species is the largest yet found of this group, measuring 6 mm. in breadth by 2.5 mm. in height.

The shell is fawn flamed with red.

Apex large, of two whorls, finely spirally lirae, about fifteen lirae counted from above, almost a varix intervening before the adult radial sculpture begins. This, on the first adult whorls, consists of about one hundred regular fine radials, the interstices being finely concentrically striate, almost giving the effect of fine beading to the radials.

The shell is flat-topped, the mouth large, while the umbilicus is narrow and deep, measuring about one fourth of the basal breadth.

***Luinodiscus tumidus* Odhner 1917.**

Plate III., fig. 2.

1917—*Endodonta* (*Charopa*) *tumida* Odhner, Kungl. Svensk., Vetensk., Handl. Bd. 52, No. 16, p. 72, pl. 3, figs. 72-74, Sept. 19. Noonkanbah, Fitzroy River, North-West Australia.

Odhner's description was somewhat brief, but from a paratype more details can be given.

Shell discoidal, spire concave, umbilicus moderately wide (narrow, half the width of the last whorl, Odhner) mouth open lunate no teeth in aperture outer lip thin columella straight slight callus joining lips but outer lip descending a little so that it does not reach above the level of the last whorl, sutures deep, almost excavate, whorls well rounded. The apical whorls are two, ending in a varix, and are sculptured with faint concentric striae which are overridden by distant radial lirae of the same character as the adult sculpture. This consists of regularly closely spaced ridges, about eighty on the first adult whorl and continuing similarly closely packed to the end of the last whorl. The interstices are very finely, regularly, closely, concentrically striate. The type measured 3.9 mm. in breadth, the height 2 mm., the specimen above described being very slightly smaller.

It is curious that the majority of Western Australian Charopids so far found have the apical whorls concentrically striate, the striae varying in strength, thus while *cupreus* has the striae well marked almost lirae, *sublestus* has the whorls almost smooth, the concentric striations being seen only by a strong lens and then they are obscure. The present species has the apex

somewhat differently sculptured, the concentric striae being overridden by distant radials, the forerunners of the adult sculpture. As the shell is also concave above, a feature not seen in any southern shell, a new subgenus *Corinomala* being introduced with *E. tumida* as type.

Genus **EPINICIUM** gen. nov.

Type **E. restifer** sp. nov.

Plate I., fig. 26.

A very beautiful shell sent by Mr. Glauret from Serpentine attracted by the bold ridges, recalling those of the much smaller Eastern *Egilomen*.

Shell small, subdiscoidal, spire a little elevated, whorls rounded, loosely coiled, sutures deep, last whorl rounded, descending in front, mouth obliquely semicircular, outer lip thin, columella straight, umbilicus wide, cavernous, walls steep.

Coloration deep brown. Apex tip smoothish, finely radially striate, succeeded in the adult by strong distant radial ribs, the interstices closely radially striate, the ribs on the last whorl numbering about thirty-five, the last ten before the aperture being crowded. Breadth 4 mm.; height 2.5 mm.

This genus differs from *Luinodiscus* in its smoothish apex, sculpture and widely umbilicate form, and from *Pernagera* in its depressed shell, different apex, sculpture, and umbilical features.

One specimen, dead, from Peppermint Grove, is larger, flatter, and with more ribs, the umbilicus wider, and may for the present be regarded as a subspecies only, **E. r. firmatum** nov.

Genus **DUPUCHAROPA** Iredale 1937.

1937—*Dupucharopa* Iredale, Austr. Zool., Vol. VIII., p. 332, Meh. 12.

Orthotype *Helix millestriata* Smith.

Medium size Charopid shells with depressed spire, narrow deep umbilicus, and sculpture of fine radials with fine spiral striation throughout."

The size separates this from most Charopids but the distinction in sculpture must be characteristic, the spiral striations being continuous over the radials, a very uncommon feature.

**Dupucharopa millestriata** Smith 1874.

1874—*Helix millestriata* Smith. Zool. Voy. Erebus & Terror, Moll., p. 2, pl. 4, fig. 5. Dupuch's I., West Australia.

1894—*Patula millestriata* Smith. Proc. Malac. Soc. (Lond.), Vol. I., p. 87, June.

1916—*Endodonta millestriata* Hedley, Journ. Roy. Soc., West Austr., Vol. I., p. 220. (p. 71 in separate).

Smith described the species as follows: "Shell thin, horn-colour perspective, umbilicated, depressedly orbicular, ornamented with very close arcuately-radiating thread-like riblets, which are coarser on the upper than the lower surface, entirely covered with microscopic spiral striations, which are continuous on, and between the riblets, spire nearly flat, only slightly elevated; whorls five, slowly increasing, rather convex, separated by a deepish suture, last not descending in front; the umbilicus occupying one-fourth the width of the base; mouth roundly-lunate; peristome simple, thin, columellar

margin a little dilated above. Greatest diameter 7 mill., smallest 6; height 3. Hab. Dupuch's Is., West Australia (Richardson). This small but prettily sculptured species is chiefly characterised by the fine riblets, and the microscopic spiral striations, which are not, as in some other species, interrupted by the riblets, but are continuous over them. The inferior surface is slightly shining, the upper not so."

Smith, later, added: "This is the largest of the W. Australian *Patulae* at present described. Several bear a very strong family resemblance, but appear to be distinguishable in certain minute details."

### FAMILY MICROCYSTIDAE.

This family comprises many small flattened conoid shells of thin shell and glassy appearance, whose exact relationship must be determined by anatomical examination. So far only one group, with two species, has been discovered and in shell characters it has shown peculiarities sufficient to differentiate it from all East Australian groups.

Genus **WESTRACYSTIS** Iredale 1933.

1933—*Westracystis* Iredale, Rec. Austr. Mus., Vol. XIX, p. 56, Aug. 2.

Orthotype *Lamprocystis lissa* Smith.

Smith described the type species in the genus *Lamprocystis*, observing that it was "well characterised by the peculiar dentiform thickening of the columella and the ridge which arises from it, and passes up the very contracted umbilicus." Hedley transferred it to *Microcystis*, but it was obviously more closely related to *Lamprocystis*.

***Westracystis lissus* Smith 1894.**

1894—*Lamprocystis lissa* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 86, pl. VII., figs. 22-23, June; Queen's Islet, Parry Island (Walker); Burner (error for Barrier) Ranges (Cox), North-West Australia.

The first locality, Queen's Islet, is here selected as the type locality. Smith's description reading: "Shell narrowly perforate, orbicular, depressedly conoid above, thin, horny, shining, sculptured with very thin growth striae and microscopic spiral striations; whorls five, little convex, narrowly marginalate below the suture, the last whorl slightly descending; spire shortly conoidal, rather obtuse at the apex; aperture obliquely lunate, small; peristome thin, the margins approaching, joined by a thin callus, the columella thickened, forming a peculiar tooth above the perforation; umbilicus very narrow, furnished with an intrusive keel terminating at the columellar tooth. Breadth 8.5; height 5 mm."

***Westracystis tentus* sp. nov.**

Plate III., fig. 14.

A large number of specimens, collected by W. W. Froggatt in the Barrier Range, all show an engraved umbilicus, a feature not recorded by the very accurate Smith in his description of *W. lissa*, though he carefully examined the umbilical features. Yet this is a feature of many members of this family.

The Barrier Range species is smaller, less elevated, the umbilical ridge less notable and the umbilical cavity is filled with a gum-like matter. It measures 7 by 4.25 mm. against 8.5 by 5 mm. The umbilicus is also quite open, and though narrow would not be termed "very contracted."



FAMILY **HELICARIONIDAE**.

This family is based on Tasmanian and Eastern Australian molluscs, which, though sluglike in form, still retain a thin semi-circular thin shell. Many species are known, extending as far north as Cape York, and extralimital species north of that place have been included. None is known from North-West Australia, while a single species is included from South-West Australia, although the group is absent from South Australia.

The local form has a shell quite unlike that of the Tasmanian and Victorian species, but apparently has a black animal like that of the latter, as Quoy and Gaimard recorded it under the name *Vitrina nigra*, which they introduced on account of the black colour of the animal.

Genus **LUINARION** Iredale 1933.

1933—*Luinarion* Iredale, Rec. Austr. Mus., Vol. XIX., p. 38, Aug. 2. Haplo-type *Helicarion thomsoni* Ancy = *Vitrina castanea* Pfeiffer.

*Luinarion* was introduced as a subgenus of *Helicarion*, but it seems to stand further apart, as the shell is so unlike that of other Australian Helicarionids that it has not been recognised up to the present although described eighty years ago.

Shell with the spire a little elevated, smooth, somewhat depressedly globose, mouth large, open, subcircular, outer lip, sinuate, receding basally, base convex, columella arched, a little reflected. Shell fragile.

**Luinarion castaneus** Pfeiffer 1853.

Plate III., fig. 1.

- 1832—*Vitrina nigra* Quoy and Gaimard, Voy. de l'Astrol., Zool., Vol. II., p. 136, part only (Western Port, Victoria) and King George's Sound, West Australia.
- 1853—*Vitrina castanea* Pfeiffer, Mon. Helic. Viv., Vol. III., p. 5, (pref. May) Australia.
- 1854—*Vitrina castanea* Pfeiffer, Proc. Zool. Soc. (Lond.), 1852, p. 56, Mch. 22, 1854. Australia.
- 1854—*Vitrina castanea* Pfeiffer, Syst. Conch. Cab. (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XI., p. 24, pl. 6, figs. 1-4. Australia (in my collection).
- 1862—*Vitrina castanea* Reeve, Conch. Icon., Vol. XIII., pl. VI., sp. 37, May (ex Verreaux in Mus. Cum. "chestnut olive").
- 1868—*Vitrina castanea* Cox, Mon. Austr. Land Shells. p. 84, pl. XIV., fig. 11, May, copied from Reeve (colour all wrong).
- 1885—*Helicarion castaneus* Tryon, Man. Conch., Ser. II., Vol. I., p. 169, pl. 38, fig. 41, July 3. Bad copy of Pfeiffer's coloration.
- 1889—*Helicarion thomsoni* Ancy, Le Naturaliste, 1889, p. 19. Geographe Bay, South-West Australia.
- 1895—*Helicarion thomsoni* Hedley, Proc. Malac. Soc. (Lond.), Vol. I., p. 260.
- 1916—*Helicarion thomsoni* Hedley Journ. Roy. Soc. West Austr., Vol. I., p. 220 (71 in separate).

Quoy Gaimard wrote "Le port du Roi Georges nous a fourni des individus plus petits, (than the Victorian species), vivant sous les arbres,

loin de l'eau douce." Although Cox recorded this note in the earliest catalogue of our Land Shells by himself in 1864, Smith in 1894 wrote "No species of *Vittrina*, *Helicarion* . . . are yet known from this region." This was corrected by Hedley, who pointed out Aucey's description of 1889, but also overlooked Quoy & Gaimard's notice. Apparently everyone has omitted notice of Pfeiffer's *castanea*, which, published in 1853, is undoubtedly the present species.

#### FAMILY CHLORITIDAE.

This family comprises many shells covered with a periostracum bearing hairs but, through lumping, species without such a covering are commonly included. The typical *Chloritis* is a large flattened umbilicate shell with a recurved outer lip, and the apex granulose. It is essentially of northern origin, and species occur throughout East Australia as far south as Victoria and along the north coast. However many species have been referred to this group, whose claims are very doubtful and a redistribution is sorely needed. Gude reviewed the series, and went so far as to group all the Australian species, whatever their form, under *Austrochloritis*, a somewhat peculiar conclusion.

Genus **DAMOCHLORA** Iredale 1938.

1938—*Damochlora* Iredale, Austr. Zool. Vol. IX., p. 97, Nov. 30. Orthotype *Helix millepunctata* Smith.

This generic name was introduced for some North-Western species, which Smith placed under *Helix*, using as a subgenus *Chloritis*, the type species being described as minutely punctate and with the form of *delessertiana*, while *rectilabrum* was subgranulose, clothed with a thin scabrous epidermis and the form unlike. It is probable that these are not at all closely related, and in order to stress this point the subgeneric name *Perochlora* is introduced, the apertural characters of the type, *rectilabrum*, reading quite differently.

#### *Damochlora millepunctata* Smith 1894.

1894—*Helix (Chloritis) millepunctata* Smith, Proc. Malac. Soc. (Lond.). Vol. I., p. 88, pl. VII., fig. 11, June. Baudin Island, North-West Australia.

Smith's description reads: "Shell orbicular, widely umbilicate, thin, horny, subpellucid; whorls five, slowly increasing, everywhere minutely punctate, convex, sutures profoundly impressed, sculptured with thin obliquely arcuate growth-striae, last whorl rounded at the periphery, scarcely descending in front; aperture oblique and broadly lunate, spire very short, rather obtuse to the apex; peristome thin, very little thickened, narrowly expanded and reflected; columellar edge very oblique, a little arcuate, dilated a little above where it joins the whorl. Diam. maj. 16, min. 13 mm.; alt. 8.5 mm. Aperture 6 high, 7 broad. *Hab.*—Baudin Island, N.W. Australia. This species has much the general aspect of *H. delessertiana*. It is, however, flatter, and, of course, quite different in sculpture."

#### *Damochlora cassiniensis* Smith 1894.

1894—*Helix (Chloritis) millepunctata* var. *cassiniensis* Smith. Proc. Malac. Soc. (Lond.), Vol. I., p. 88, pl. VII., fig. 12, June. Cassini Island, North-West Australia.

Smith briefly described this: "Shell smaller than the typical form, umbilicus a little narrower, aperture more contracted, peristome a little more

thickened. Diam. maj. 14.5, min. 10.5 mm.; alt. 7 mm. Aperture 5 high, 5 broad. Hab. Cassini Island, N.W. Australia. Although smaller and differing from the type in the points referred to, it seems advisable to consider this form as a variety, rather than as a distinct species."

**Damochlora rectilabrum** Smith 1894.

1894—*Helix* (*Chloritis*) *rectilabrum* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 88, pl. VII., fig. 14, June. Parry Harbour, N.W. Australia.

The description given by Smith reads: "Shell orbicular, depressed, umbilicate, pallid brownish, subgranulate, clothed with a thin scabrous epidermis; spire a little elate, obtuse to the apex; whorls five slowly increasing, convex, sutures profoundly impressed, last whorl rounded at the periphery, very slightly keeled, descending slightly in front; aperture almost horizontal, lunate; peristome thin, narrowly expanded and reflected, margins coming together, the basal edge straightened a little towards the columellar dilation. Diam. maj. 13, min. 11 mm, alt. 6 mm. Aperture 4 high, 5.5 broad. Hab. Parry Harbour, N.W. Australia.

A dead specimen devoid of epidermis does not appear nearly so granular as fresh living examples, although traces of the granulation, especially upon the apical whorls, are discernible."

Genus **KIMBORAGA** Iredale 1933.

1933—*Kimboraga* Iredale, Rec. Aust. Mus., Vol. XIX., p. 50, Aug. 2. Orthotype *Chloritis micromphala* Gude.

Gude named a large series of shells under *Chloritis* many of which appear to be not closely related to the genotype of *Chloritis*, while some, such as the present series, seem to have very little affinity.

Shell globose, thin, elevated spire, mouth large, subcircular, outer lip a little expanded, thin, columella broadly reflected, umbilicus deep, open, apex smooth, shining, with faint growth radials only. No periostracum discernible and sculpture of fine growth radials crossed by fine concentric lines. The apex is large, a little eccentric, a half whorl smooth, another whorl finely striate radially, and three adult whorls only. The related, superficially, forms *Gloreugenia* and *Parglogenia* have the apex small and regularly coiled, and the first whorl and a half are succeeded by five adult whorls.

**Kimboraga micromphala** Gude 1907.

Plate III., fig. 12.

1907—*Chloritis micromphala* Gude, Proc. Malac. Soc. (Lond.), Vol. VII., p. 231, pl. XXI., fig. 6, April 3. Barrier Range, North-West Australia.

The generic details above given cover the species: the coloration is pale fawnish, and the norm measures 28 mm. in breadth and 18 mm. in height, the aperture being about 11 mm. high and broad, the outer lip descending appreciably in front.

[**Parglogenia forrestiana** Angas 1875.

1875—*Helix forrestiana* Angas, Proc. Zool. Soc. (Lond.), 1875, p. 389, pl. XLV., figs. 3, 3a. North-West Australia.

The locality "North-West Australia," almost certainly refers here to an extra-limital locality, as, from the description, the shell is very close to, if not identical with *pelodes* Pfeiffer = *pseudoprimum* Pilsbry. The last named

was also described from north-western Australia, by which Pilsbry intended Port Darwin, which is politically in the Northern Territory. An earlier name still may be *subgranosa* Le Guillou, and the shell has also been known as *prunum* Férussac, which has been shown to be very different. Misled by the incorrect association, Hedley confused the shell, *Kimboraga micromphala*, and thus included *forrestiana* in his W.A. list.]

Genus **TORRESITRACHIA** Iredale 1933.

1933—*Torresitrachia* Iredale, Rec. Austr. Mus., Vol. XIX., p. 55, Aug. 2.

Orthotype *Helix endeavourensis* Brazier.

Shell subdiscoidal, spire a little obtusely elevated, vitreous, whorls rounded, sutures impressed, periphery rounded, mouth subcircular, open, outer lip thin, reflected all round, a little thickened basally, columella almost straight, a little reflected, umbilicus narrow, deep, open, showing coiling and not obscured by columellar reflection. Coloration greenish white, unicolor. Apex smooth, adult sculpture close radial ribbing almost ridges above, base smooth save for growth striae.

This North Queensland style of shell appears to travel along the north coast into North-West Australia.

***Torresitrachia bathurstensis*** Smith 1894.

Plate 3, Fig. 2.

1894—*Helix (Trachia) bathurstensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 93, pl. VII., fig. 20, June. Heywood Island and Bathurst Island, King Sound, N.W. Australia.

A curious complication is seen in the fact that the specific name is taken from one island, and the type shell came from the other; these islands lie at each side of the Sound and the species are probably distinct on each island. Curiously enough the specimen before me, collected by Mr. J. J. Walker, is a paratype, but it has no definite locality.

This specimen is very like the species of *Torresitrachia* but can be separated by the finer, closer, and more regular character of the costulation. The type from Heywood Island measured 15.5 mm. in breadth by the height omitted, while the Bathurst Island shell was 13.5 mm. in breadth, again no height being given. The paratype abovementioned and here figured measures 14.5 mm. in breadth and is 8.5 mm. in height. The ribbing on the base is stronger than on the base of the Queensland shells, but is not as strong as on the upper surface nor is it regular.

***Torresitrachia monticola*** sp. nov.

Plate III., fig. 13.

The species of *Torresitrachia* are found on the islands of Torres Strait and along the north coast of Queensland. The occurrence of similar shells on the islands off the North-West Coast was unexpected, but not so surprising as the recognition of a form among the shells collected by W. W. Froggatt in the Barrier (Napier) Range, many miles inland.

This species is flattened, subdiscoidal, whorls rounded, openly narrowly umbilicate, mouth subcircular, open, lips thin reflected, columella arcuate. The apex is smooth, a subvarix separating this from the adult sculpture which consists of deep well separated very regular costulations, which continue onto the base where however they are less marked. Coloration trans-

lucent and glassy. The umbilicus is narrow, deep, only about one eighth the width of the base yet the previous whorling may be seen therein. The outer lip is reflected all round, though thin, and the columella is little thickened. Breadth 15.5 mm.; height 9.5 mm.

The costulations are a little stronger than in the coastal shell, the spire a little more elevated and the umbilicus a little wider.

Genus **BAUDINELLA** Thiele 1931.

1931—*Baudinella* Thiele, Handbuch syst. Weicht., Vol. I., p. 685. Orthotype, *Helix baudinensis* Smith.

1933—*Gonobaudinia* Iredale, Rec. Austr. Mus., Vol. XIX, p. 55, Aug. 2. Orthotype, *Helix baudinensis* Smith.

Thiele's Handbuch was not available when I introduced *Gonobaudinia*, and Thiele's subordination of his subgenus *Baudinella* to *Angasella* is difficult to understand. Small, stout, widely umbilicate with contracted mouth, it resembles no other Australian shell.

Shell discoidal, spire flattened, whorls few, last descending a little, mouth small, broader than high, outer lip thickened and reflected, with a ditch behind, umbilicus wide and open, nearly half the width of the base. The apex is granulose of about two whorls, the adult sculpture developing without any varix intervening: this consists of stout radial ribs with wide interspaces, the ribs running across the upper surface in a sigmoid manner, then with an even curve into the umbilical cavity where twenty-one may be counted on the last whorl. Along the upper part of the last whorl there is a deep depression which causes the eccentricity in the rib development, and this depression appears in the outer lip as a tooth.

**Baudinella baudinensis** Smith 1893.

Plate III., fig. 9.

1893—*Helix* (*Gonostoma*) *baudinensis* Smith, The Conchologist, Vol. II., p. 97, fig. in text, Mch. 25. Baudin I., North-West Australia (J. J. Walker).

The generic characters are, at present, sufficient to enable the recognition of this bizarre little shell, which measures 6 mm. in breadth by 3 mm. in height. There is a stout epiphragm in the aperture of the shells collected alive.

Genus **SETOBAUDINIA** Iredale 1933.

1933—*Setobaudinia* Iredale, Rec. Austr. Mus., Vol. XIX, p. 55, Aug. 2. Orthotype *Helix collingii* Smith.

The detailed specific account following shows that this differs from the preceding genus in the essential distinction that the shell is covered with a pilose periostracum. Otherwise it is larger, lacks the characteristic sculpture, and has a more open mouth. It is almost certain that it is not closely related.

**Setobaudinia collingii** Smith 1893.

1893—*Helix* (*Gonostoma*) *collingii* Smith, The Conchologist, Vol. II., p. 98, fig. in text, Mch. 25. Baudin I., North-West Australia (J. J. Walker).

As no shells are available in this case, Smith's account reads: "Shell flatly discoidal, with the spire only very little raised above the body-whorl, rather openly umbilicated, light brown above, and pale beneath. When in

fresh condition the surface is covered with a thin, shortly pilose epidermis. Worn shells exhibit innumerable minute punctures showing where the short delicate setae have been. Whorls  $4\frac{1}{2}$ , regularly and rather slowly increasing, moderately convex, and separated by a deep sutural line, besides the punctures, exhibiting fine lines of growth; last whorl rounded at the periphery, only very feebly deflexed close to the aperture, and exhibiting a slight depression above about the middle of the upper margin of the peristome. Aperture somewhat triangular in outline, but with rounded angles, almost horizontal in position; peristome narrowly reflected above, more broadly expanded along the basal margin, especially over the umbilicus. A conspicuous tubercle or prominence occurs on the inner edge of the basal margin, and a less pronounced one within the upper margin corresponding to the slight depression upon the outer surface of the whorl. Breadth 10 mm.; height 4 mm."

Genus **WESTRALTRACHIA** Iredale 1933.

1933—*Westraltrachia* Iredale, Rec. Austr. Mus., Vol. XIX, p. 55, Aug. 2.  
Orthotype *Trachia froggatti* Aney.

This generic name was introduced for a number of species, which Aney had, with great doubt, referred to *Trachia*. The species are flattened helicoids with low spires and keeled or subkeeled periphery, narrow umbilicus and transverse mouth sometimes basally flattened and indistinctly toothed. Although generally smooth and shining, the type is granulose and dull, and it may be that the smooth species should constitute a separate subgenus, which may be called **Zygotrachia** the species, *W. alterna*, being named as type.

**Westraltrachia froggatti** Aney 1898.

Plate III., fig. 10.

1898—*Trachia froggatti* Aney, Proc. Linn. Soc. N.S.W., Vol. XXII., p. 774, pl. XXXVI., fig. 2, June 4. Osear Range, 100 miles inland from Derby, North-West Australia (W. W. Froggatt).

Shell small, subconical, depressed, stout, spire a little elevated, whorls flattened, sutures little impressed, last whorl acutely keeled, mouth oblique, outer lip expanded and a little recurved. Apex radially finely subgranose, adult sculpture flattened coarse granulation finer on the base.

**Westraltrachia derbyi** Cox 1892.

Plate III., fig. 6.

1892—*Helix (Hadra) derbyi* Cox, Proc. Linn. Soc. N.S.W., Ser. 2, Vol. VI., p. 566, pl. XX., figs. 4, 5, May 23, Derby District, North-West Australia (W. W. Froggatt).

1894—*Helix (Trachia) derbyana* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 92, pl. VII., fig. 19, June. Burner (error pro Barrier) Ranges, Derby, North-West Australia.

Shell small, subdiscoidal, spire a little elevated, whorls little rounded, sutures impressed, umbilicate, umbilicus narrow, deep, columella reflected, mouth open, outer lip a little reflected with a slight submodulation on base. Coloration whitish marbled with brown flames above, a post peripheral brown band, rest of base dirty white, shell shining. Apex smooth, adult sculpture faint growth lines only. Breadth 11 mm.; height 6 mm. Collected on the Barrier (= Napier) Range by W. W. Froggatt.

**Westraltrachia orthocheila** Ancey 1898.

Plate III., fig. 8.

1898—*Trachia orthocheila* Ancey, Proc. Linn. Soc. N.S.W., Vol. XXII., p. 774, pl. XXXVI., fig. 4. June 4. Oscar Range, 100 miles inland from Derby, North-West Australia (W. W. Froggatt).

Shell a little larger than the preceding, subdiscoidal, spire scarcely elevated, whorls scarcely rounded, sutures impressed, umbilicus narrow, deep, columellar reflection small, outer lip thin a little reflected, mouth open with no basal subnodulation nor flattening. Coloration whitish marbled above, with a brown band below the periphery, the rest of the base white, shell shining. Apex smooth, and only fine growth lines seen on the adult whorls. Breadth 13-14 mm., height  $6\frac{1}{4}$ -7 mm.

The Oscar Range is twenty miles distant from the south end of the Napier (or Barrier Range), and its shell fauna appears to be different although this species is very close to *derbyi*.

**Westraltrachia alterna** sp. nov.

Plate III., fig. 17.

Shell large for this genus, subdiscoidal, spire a little elevated, whorls slightly rounded, sutures impressed, last whorl descending a little, subkeeled, mouth flattened horizontally. The apical whorls, two in number, are smooth, the adult four and a half sculptured only with regular striae, which become more distant on the last whorl. Outer lip reflected, base of lip flattened and almost nodulose, columella broad, angularly joining the base of the lip, reflected. Umbilicus narrow, open, half hidden by the reflection of the columella. Coloration horny, banded with dull brown above and below the periphery, base almost white. Breadth 17 mm., height 9 mm. Collected on the Barrier Range (i.e., Napier) by W. W. Froggatt.

**Westraltrachia increta** sp. nov.

Plate III., fig. 16.

Shell large, not as large as preceding, conical, spire elevated, whorls rounded, last subkeeled a little descending at the aperture, the mouth flattened horizontally. Colour pale brownish white banded above and below the periphery with broad brown bands, the base dirty white. The two apical whorls are smooth, the adult four and a half have only subobsolete striae vanishing on the base. The umbilicus narrow, almost concealed by reflected columella, which is broad and almost angularly meets the base which is flattened and almost subnodulose. Breadth 15.5 mm., height 9.5 mm. Collected by W. W. Froggatt on the Barrier (= Napier) Range.

Genus **QUISTRACHIA** gen. nov.Type **Trachia monogramma** Ancey.

Shell thin, subdiscoidal, spire a little elevated, whorls rounded, umbilicus narrow, perspective, outer lip thin, a little reflected, subcircular open mouth, columella rather broadly reflected.

Although hitherto classed with the preceding this shell is unlike any of the *Westraltrachia* in texture and form, and is nothing like *Rhagada*.

***Quistrachia monogramma* Aneey 1898.**

Plate III., fig. 20.

- 1898—*Trachia monogramma* Aneey, Proc. Linn. Soc. N.S.W., Vol. XXII., p. 775, pl. XXXVI., fig. 3, June. Oscar Range, N.W.A. (W. W. Froggatt).

In addition to the characters mentioned above, the shell is horny brown with a darker brown on peripheral band. The apical whorls are smooth as is the rest of the shell save for indistinct growth lines, the whole surface slightly shining ("oleoso," Aneey wrote). The figured shell measures 17 mm. in breadth by 10 mm. in height, while the type, a unicum, measured 15.5 by 8.5 mm.

**[*Helix australis* Menke 1843.**

- 1843—*Helix (Helicella) australis* Menke, Moll. Nov. Holl. Spec., p. 6 (Apl. 11), among limestone rocks at Mount Eliza near the Swan River.  
 1853—*Helix australis* Pfeiffer, Syst. Conch. Cab. (Martini & Chemnitz), ed. Knster, Bd. I., Abth 12, pt. 2, p. 276, pl. 123, figs. 7, 8 (after June, 1852). Specimen from Menke Collection figured.  
 1852—*Helix australis* Reeve, Conch. Icon., Vol. VII., pl. 131, sp. 803, Oct. Swan River, New Holland. Mus. Cuming.

This species has caused a lot of trouble, yet it seems certain that it is merely a South African shell mixed with the Western Australian collection of Dr. L. Preiss. Why this has remained on the list, when this possibility was known is curious. Reeve noted, "A small striped species of European aspect," while of the South African shell he wrote, "Closely allied to a well-known European form." Menke himself compared it with a South African shell, and Benson recorded that "this South African representative could not be refound by Dr. Bacon." Smith questioned the identity of Reeve's specimen with Menke's species, and placed the shell under *Xerophila*, a European subgenus. So it may be omitted from Western Australian lists as it is unlike any local shell in size and form.]

**FAMILY XANTHOMELONTIDAE.**

The most notable mollusc in North Australia is a large thick globose shell, for which many years ago the descriptive name, *Xanthomelon*, was introduced. It is common about Port Darwin, and goes eastward along the coast round the Cape York Peninsula and down towards Moreton Bay. As far as yet is known this form does not occur in Western Australia, an extraordinary result from superficial knowledge. In the interior of Australia, apparently degenerate relations live, and these penetrate into Western Australia in the mid and southern areas. This series, named *Sinumelon*, appears to be characteristic of the Centralian Area; different forms, species or genera being developed on each Range.

**Genus SINUMELON Iredale 1930.**

- 1930—*Sinumelon* Iredale, Vict. Naturalist, Vol. XLVII., p. 120, Nov. Haplo-type *Helix nullarborica* Tate.  
 1932—*Notobadistes* Cotton and Godfrey, South Austr. Naturalist, Vol. XIII., pp. 169-170, Aug.-September 30. Orthotype *Helix bitaeniata* Cox = *flindersi* Angas.

These desert living Xanthomelontids, ranging all through the interior in suitable places, enter into southern Western Australia, and apparently all the



subgroups appear there. Shells small for the family, subglobose, more or less openly umbilicate, no definite sculpture, longitudinal growth ridges overriden by granulation, mouth subcircular, open, the columella thickened and reflected.

***Sinumelon nullarboricum* Tate 1879.**

Plate III., fig. 19.

1879—*Helix nullarborica* Tate, Trans. Proc. Phil. Soc. Adelaide, South Austr., 1878-9, p. 133, pl. VI., ff. 1 a-b, ex p. 126, *nom nud.* Bunda Plateau, Nullarbor Plain, South Australia.

Shells from Eucla agree in detail with paratypes of Tate's species. These are subglobose, dirty white, sculptured with rough radials, spire a little elevated, umbilicus narrow, columella thickened, outer lip thickened.

The two apical whorls are smooth and shining, but show under a lens very fine radials towards the suture. The rude irregular radials show dents on the last whorl, which appear concentrically as if they were broken rough incised lines, but fine incised concentric lines may be seen on the base of some specimens subordinate to the denting. The columella is reflected, almost concealing the umbilicus, which is encircled by a ridge.

Height 14 mm., breadth 16 mm.

***Sinumelon datum* sp. nov.**

Plate III., fig. 18.

1895—*Helix angasiana* Hedley, Proc. Malac. Soc. (Lond.) Vol. I., p. 260, July. Eucla, Western Australia.

Not *Sinumelon godfreyi* Iredale, Rec. Austr. Mus., Vol. XIX, p. 52, Aug. 2, 1933, new name for *Helix angasiana* Pfeiffer, Journ. de Conch., Vol. X., p. 228, pl. X., fig. 2, July 1, 1862: near Lake Torrens, South Australia.

Shell subglobose, broader than *nullarboricum*, with the spire less elevated, the sutures deeper, the umbilicus wider and more open, the columella more curved and reflected, the outer lip reflected but not thickened. Coloration dirty white.

The one and a half apical whorls have more prominent radial sculpture easily seen with a lens, the adult sculpture being rough radials with granulo-subordinate sculpture, the grains lengthening on the last whorl into broken radials. The dents are less marked and even more concentrically arranged. Breadth, 19 mm.; height 14 mm. Type from Eucla. Shell from Madura larger and broader but obviously conspecific.

***Sinumelon kalgum* sp. nov.**

Plate III., fig. 25.

From Hannans, Kalgoorlie and Lake Kalgoorlie dead shells (which were probably coloured in life) appear to be relations of the *fodinale* series. They are stouter than *datum*, and have not the deep sutures of that species, and the sculpture differs. The shell is subglobose, stout, spire short, sutures impressed but not subcanaliculate as appear those of *datum*. The apical whorls are not so markedly striate, while the radials are finer and the delicate granulation present never becomes radial, and there appear to be no signs of concentric striae nor any denting. The mouth is more vertical and

more circular, while the umbilicus is more hidden though still open: the columella thickened with the outer lip reflected. Breadth, 20 mm.; height, 17.5 mm.

Bednall's record of *fodinalis* (Trans. Roy. Soc., South Austr., Vol. XVI., p. 63, Dec. 1892), from between Victoria Spring and Fraser Range may refer to this species.

***Sinumelon lennum* sp. nov.**

Plate III., fig. 21.

1892—*Helix* (*Galaxias*) *perinflata* Bednall, Trans. Roy. Soc. South Austr., Vol. XVI., p. 62, December. Cavanagh Range. About three miles south of Camp 58, Victoria Desert. Between Fraser Range and Yilgarn Goldfields, Western Australia.

Not *Helix perinflata* Pfeiffer, Proc. Zool. Soc. (Lond.), 1863, p. 528, Apl. 20, 1864, MacDonnell Ranges, Central Australia.

Representatives of the *perinflata* series occur throughout the interior of South-West Australia varying in size and form according to locality.

Shell subglobose, spire short and conical, whorls rounded, sutures impressed, umbilicus very narrow hidden by reflection of columella, mouth large and subcircular. Coloration green. Apex finely granulated, adult whorls  $4\frac{1}{2}$ , sculptured with faint radial growthlines, with irregular granules covering the whole surface tending to lengthen into beaded radials. Breadth, 24 mm.; height, 21 mm. (type from Boulder).

Specimens from Madura are broader with the same height, the spire being shorter and the body whorl more swollen; these measure 26 mm. in breadth by 21 mm. in height, and may be called ***S. l. mutuuum*** subsp. nov.

***Sinnumelon vagente* sp. nov.**

Plate III., fig. 24.

From Mt. Singleton, inland from Geraldton, comes a relation of *perinflata*, more elevated and less inflated than *lennum*, with a stronger granose sculpture.

Shell subglobose, spire short, whorls rounded, sutures impressed, umbilicus very narrow almost concealed by expansion of columella, mouth large, round, outer lip thin. Coloration brownish green. Apex finely radially granulose, adult whorls four, sculptured with fine irregular growth radials which are overridden by a fine granulation.

Columella strongly reflected and united to the outer lip by a thin callus. Breadth, 21 mm.; height, 19 mm.

Genus **PLEUROXIA** Aney 1887.

1887—*Pleuroxia* Aney, Conch. Exchange, Vol. II., pt. 3, p. 38, September, new name for

1864—*Angasella* Angas, Proc. Zool. Soc. (Lond.), 1863, p. 521, Apl. 20, 1864, ex A. Adams MS. Haplotype *Helix cyrtopleura* Pfeiffer.

Not *Angasiella* Crosse, Journ. de Conch., Vol. XII., p. 50, footnote, Jan. 1, 1864.

These shells, referred on account of anatomical details, to the family Xanthomelontidae, are very unlike typical members of that family in every conchological feature.

The type has the spire depressed, the shell discoidal, the umbilicus very wide and open, the mouth circular, lip a little reflected; the apex is granosely radiate, the radial sculpture developing into ribs, the grains continuing as a subordinate feature. The south-western species, represented by *oligopleura*, have the apex smooth, spire elevated, shell subdiscoidal, sometimes subglobose, the mouth circular, with the lips continuous, the umbilicus narrow. The sculpture is similar but coarser, and this series is separated as a new subgenus, **Angasietta**.

The Gauthaume Bay species, *P. abstans*, however, has the apex coarsely granular, spire elevated, the umbilicus moderately wide, the mouth circular, lips continuous, expanded rather broadly and constricted behind, and is therefore subgenerically differentiated as **Gantomia** nov.

### **Pleuroxia polypleura** Tate 1899.

Plate III., fig. 27.

1899—*Angasella polypleura* Tate, Trans. Roy. Soc. South Austr., Vol. XXIII., p. 246, pl. VI., figs. 2a-c, Dec. Bunda Plateau, Great Australian Bight, South Australia.

1879—*Helix cyrtopleura* Tate, Trans. Proc. Phil. Soc. Adelaide, South Austr., 1878-9, p. 126, not of Pfeiffer, 1862.

1895—*Helix cyrtopleura* Hedley, Proc. Malac. Soc. (Lond.), Vol. I., p. 260, July, not of Pfeiffer, Journ. de Conch., Vol. X., p. 227, pl. X., fig. 4, July 1, 1862.

Shell subdepressed, flattened, widely umbilicate, with about sixty sigmoid threadlike ribs, the interspaces coarsely granular, the apex large and smooth, breadth 18 mm., height 10.5 mm. Specimens from the road between Madura and Mundrabilla agree in size and sculpture and one is here figured. The umbilicus is better described as narrow and open, not much more than one-fifth the width of the base, while the large open subcircular mouth has the thin lip reflected, and the lips are connected by a strong body callus. Shells collected at Newman Rocks are similar in shape and sculpture but much smaller with the umbilicus a little wider, the granulation finer. The largest measures 13.5 mm. in breadth and 8 mm. in height, and is subspecifically named **Pleuroxia polypleura elfina** nov.

### **Pleuroxia commenta** sp. nov.

Plate III., fig. 26.

Specimens collected by Mr. Charles Barrett, the famed Victorian naturalist and writer, on the Nullarbor Plains were recorded as *P. polypleura*. Better knowledge allows their description as distinct, and the exact locality proves to be Hampton Tablelands, inside the West Australian boundary.

Shell small, subdepressed, spire a little elevated, sutures impressed, whorls rounded, last whorl flattened above and then rounded, a little descending in front, mouth large, subcircular, outer lip a little reflected, umbilicus narrow, deep, open. The coloration of the living shells is a dirty brownish white. Very similar in general appearance and size to *P.p. elfina*, but a little more depressed, and with much coarser sculpture. The ribs are much stronger, more distant, and the granulation almost obsolete, the ribs numbering forty to forty-five. The mouth and umbilical features are very similar to those of the preceding. The shell measures 13 mm. in breadth by 7 mm. in height.

**Pleuroxia oligopleura** Tate 1894.

Plate III., fig. 28.

1894—*Hadra oligopleura* Tate, Trans. Roy. Soc. South Austr., Vol. XVIII., p. 193, Nov. Eyre's Sand Patch, 160 miles west from Eucla, West Australia (Adcock).

1896—*Angasella oligopleura* Tate, Rep. Horn. Sci. Exped. Centr. Austr., pt. II., Zool., p. 219, pl. XIX., fig. 39, Feb. "Flinders' Range, South Australia," error only, through interchange of localities with *H. wilpenensis* only.

"Similar to *H. cyrtopleura* (sic) but the plications sharper, higher, and about one-third less in number (35 to 40); the outer lip is thin, and the whorl is more constricted behind it. Diameters, 14.15 and 12; height, 8; height of aperture 6 mm." Topotypes agreed with this diagnosis but shells from 70 Mile Tank east of Balladonia are a little larger and flatter, and probably belong to the same subspecies that occurs on the Hampton Tableland and at Cardanumbi, west of Eyre. This subspecies is altogether larger, more depressed the last whorl flattened above and rounded below, the periphery subkeeled, and the rib sculpture much more pronounced and the ribs only about thirty in number, interstitial granulation obsolete. The coloration of the living shell is brownish white, and the type measures 18 mm. in breadth and 8.5 mm. in height, the subspecies being named **Pleuroxia oligopleura numba** nov.

**Pleuroxia gascoynensis** Smith 1894.

1894—*Helix* (*Trachia*) *gascoynensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 93, pl. VII., fig. 13, June. Gascoyne District, Western Australia (H. P. Woodward).

"Shell depressed, orbicular, broadly and openly umbilicated, whitish, rather solid; whorls four, convex, sutures deeply impressed, closely and minutely granulated, sculptured with oblique rugae or irregular rugose plicae, the two apical smoother, the last whorl rounded or subangulate at the periphery, descending conspicuously in front, the underside rugose; spire flat, apex obtuse, a little elevated; aperture subhorizontal, rounded; peristome continuous, appressed to the last whorl, narrowly expanded, the lower margin broadly dilated. Diam. maj. 12.5, min. 10 mm.; alt. 5.5 mm. Aperture 4 high, 4.5 broad. It is similar in form to *H. cyrtopleura*, Pfr., from South Australia, but differs in size and sculpture. It is smaller, flatter, and has the peristome more decidedly continuous. Rather a powerful lens is necessary to observe the fine granulation which covers the entire surface."

**Pleuroxia abstans** sp. nov.

Plate III., fig. 22.

A series labelled "On chalk, Murchison House, Gantleaume Bay," consists of dead shells, smaller than the preceding, the largest being only 10 mm. in breadth and barely 5 mm. in height, and having the apex coarsely granulose.

Shell small, subdiscoidal, spire scarcely elevated, sutures deep, whorls a little rounded, last whorl descending in front, umbilicate, umbilicus wide, open, mouth oblique, subcircular, chalky white. Apex half whorl strongly granulated, not differentiated from four adult whorls, the granules massing to form radial ribs. On the last whorl these ribs are well marked closely set ridges,

somewhat irregular in spacing, the interstices somewhat obscurely very finely grained. The ridges continue into the umbilicus which is open and about one-third the diameter of the base. The mouth is subcircular, the outer lip thickened and reflected, an antelabial ditch present; the columella is arched, reflected a little, and connects with the outer lip by a strong callus.

[*Pleuroxia radiata* Hedley 1905.

1905—*Xanthomelon radiatum* Hedley, Trans. Roy. Soc. South Austr., Vol. XXIX., p. 163, pl. XXX., figs. 4, 5, 6, December. Mt. Davies, Tomkinson Range, and Musgrave Ranges, Central Australia.

The Tomkinson Range extends across the border into Western Australia, but Mount Davies is on the South Australian side. The Mann Range is also only a short distance on the wrong side of the West Australian border, and in the same paper, Hedley recorded *Thersites basedowi*, described from the Musgrave Ranges, and now placed in the family Hadridae, and *Xanthomelon asperimum*, now regarded as *Glyptorhagada*, but with a distinct subgenus *Eximiorhagada*, was described from the Mann Ranges. These records suggest many novelties from the multitude of ranges indicated on the map running south-west from the Tomkinson Range to Mt. Margaret, and thence south to Kalgoorlie.]

#### FAMILY RHAGADIDAE.

The notable Caurine faunula is characterised by many species of mollusca of a solid chalky appearance, many with coloured bands, of normal helicoid aspect, quite unlike those from the rest of Australia.

The typical *Rhagada* is a small solid striped Helicoid with the umbilicus closed by appression of the columella; the umbilicus is narrow and open in the juvenile but rarely open in the adult, sometimes showing a chink but commonly completely closed. The only sculpture is growth lines and the mouth is roundly imate, a subbasal tubercle present. Many species are larger, some more globose, and some with regular sculpture above but the facies of all resembles each other. This family is utilised tentatively to include some species which are not solid, coming from this Dampierian Sub-Area. It is strange that so far no similar shells have been found in the Northern Territory.

The earliest Rhagadoid shells were collected by Péron and Lesueur, and later the collectors with Stokes secured similar shells. Fifty years ago that fine collector and entomologist W. W. Froggatt collected many specimens in the Barrier and Osear Ranges. A little later an extraordinary addition to our knowledge was made by another entomologist, J. J. Walker, whose official post was engineer on the surveying vessel *Penguin*. Apparently parties were landed on various islets between Broome and Darwin, and this industrious collector in his search for insects secured a large number of curious land shells. Owing to the donation of this collection to the British Museum the curator of molluscs (E. A. Smith) examined them and found so much novelty that he prepared a List of the Land Shells of Western Australia, the only monographic attempt made. Twenty years ago Dr. H. Basedow explored the Napier Range and again many land shells were procured. Although the general locality "Napier Range" was the same for Froggatt's and Basedow's collections there was so much discrepancy in the material that it became imperative to investigate their collecting grounds as otherwise recorded.

The localities visited by W. W. Froggatt are given in the Proc. Linn. Soc., N.S.W., Ser. 2, Vol. IV., pt. 2, p. 199, Sept. 20, 1889, as follows:—(1)

Ironstone Ridge, 25 miles South-East of Yeeda Station, Fitzroy River; (2) Mount Marnion; (3) Mount North Creek, Napier Range; (4) Leonard River Gorge, Napier Range; (5) Barrier Range Homestead, Napier Range; and (6) Oscar Range, north-east side.

On the other hand an account of Basedow's Expedition has appeared in the Transactions of the Royal Geographical Society of Australasia, South Australian Branch, Vol. XVIII, pp. 105-205, July 17, 1918. From the route thereon given we find that Dr. Basedow passed through the Barker Gorge in the middle of the Napier Range, then retraced his steps and went along the western side northwards to another gap where he found the limestone caves which he later named Wangalinnya Caves. Thus Basedow's localities are quite distinct from those of Froggatt though the general name Barrier or Napier Range was used by both. All Froggatt's shells were collected in the southern end of the Range and in the Oscar Range which lies some twenty miles to the south-east.

I have continually observed that our land molluses must be studied in conjunction with geographical, geological and climatic conditions. This instance provides a striking example as the variation seen in the two collections (with the same locality label) was not understood until the geography of the district was known. In a geological sketch plan which accompanies Basedow's account, the Napier Range is shown as Devonian limestone, the approach from Derby as Permo-Carboniferous, while the Kimberley block to the northward appears as Cambro-Ordovician, a pre-Cambrian sector intervening just north of the Napier Range. A peculiar note is the showing of a small patch of Permo-Carboniferous to the south-east of Wyndham whence come some peculiar snails. With regard to the variation seen in the Napier Range collections other factors, such as climatic, may have interfered as this aspect needs consideration.

Genus **RHAGADA** Albers 1861.

1861—*Rhagada* Albers, Die Heliceen, 2nd ed. (Martens), p. 108, "1860."  
Orthotype *Helix roinga* Gray = Pfeiffer.

The restricted group of true *Rhagada* comprises small shells, of flattened Helicoid aspect, but chalky, rather shining, spire little elevated, sutures impressed, whorls rounded, mouth subcircular, outer lip thin but a little reflected, inner base showing a slight tubercle, columella curved, appressed generally closing the umbilicus in the adult, a narrow perforation always visible in the juvenile stage. Sculpture of obscure radials only. Coloration white with a few coloured bands.

**Rhagada torulus** Férussac 1819.

Plate IV., fig. 1.

1819—*Helix torulus* Férussac, Hist. Moll. livr. 6, pl. XXVII., figs. 3, 4, November; Syst. Tabl. Hist. Moll., p. 34, Jan. p. 30, June 1821. New Holland (Péron) = Shark Bay, W.A.

The only locality whence Péron could have secured a shell such as Férussac figured is Shark Bay, and we find that, dealing with the natural history of Bernier Island, with which he associated that of Dorre and Dirk Hartog's Isles, he mentioned "two species of land shells extremely numerous, but all dead, occupied great stretches of the interior of the island. One was a small species of *Helix*."

Smith suggested that *reinga* Gray might be synonymous with this species, writing: It seems to me probable that the *H. torulus* Fér., is identical with this species (*reinga*). It was collected by Péron during one of the early French voyages, but the exact part of Australia, where he obtained it is not stated. Accepting this suggestion Hedley used *torulus*, and I utilised it in the Basic List, but in the more detailed examination necessary for this account I found too many discrepancies, and now record *torulus* as available for a Shark Bay shell, which is not at present in our collection.

Deshayes' description agrees with the figure which shows a subglobose, subperforate shell, smooth, white with one ante-peripheral brown band: the sutures deep, the whorls convex. The illustration is of a shell of the Shark Bay form, being more convex than the more northern *reinga* series.

### **Rhagada reinga** Pfeiffer 1846.

Plate IV., fig. 2.

- 1846—*Helix reinga* Pfeiffer, Symb. Helic., Vol. III., pp. 31, 50, 73 ex Gray Ms. New Zeal., t. 1, f. 11, 12. New Zealand, type in Pfeiffer Coll. No. 459.
- 1848—*Helix reinga* Pfeiffer, Mon. Helic. viv., Vol. I., p. 289, cites Chemn., ed. II., Helix, N. 443, t. 73, f. 8-9.
- 1851—*Helix reinga* Pfeiffer, Syst. Conch. Cab., (Mart. & Chemn.), ed. Kuster, Bd. I., Abth. XIII., Teil 2, p. 52, pl. 73, fig. 8-9.
- 1852—*Helix reinga* Reeve, Conch. Icon., Vol. VII., pl. 128, sp. 772, Oct.
- 1890 *Helix reinga* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. VI., p. 185, Dec. 16, refers to Vol. IV., p. 256, pl. 36, fig. 39, Jan. 3, 1889, where the plate was issued but no text appeared with it.

This species was described as "depressedly globose, obliquely striate, whitish, with one chestnut band and many orange lines; spire little elevated, whorls convex; aperture oblique narrow; with a hidden perforation and an obtuse tooth on the base of the mouth, breadth 15, height 10 mm. New Zealand."

The shell had not come from New Zealand, apparently Pfeiffer being misled by inspection of a plate of New Zealand shells which Gray had had prepared. This plate was never issued. A specimen from Broome is here figured as it agrees with the figure and description, and the original specimen may have been collected at Cygnet Bay along with *leptogramma* described about the same time.

### **Rhagada richardsonii** Smith 1874.

Plate IV., fig. 7.

- 1874—*Helix richardsonii* Smith, Zool. Voy. Erebus & Terror. Moll., p. 2, pl. 4, fig. 14. Dupuch's L., West Australia.
- Fig'd Tryon, Man. Conch. Ser. 2, Vol. IV., pl. 36, fig. 35, 36, cf. Pilsbry, id. ib., Vol. VI., p. 185, Dec. 16, 1890.
- 1877—*Helix elachystoma* Martens, Monatsb. Ak. Wissen Berlin, 1877, p. 273, pl. 1, figs. 8-9, May no. Mermaid Strait, North-West Australia (T. Studer).
- Fig'd Martens, Nov. Conch., Vol. V., p. 35, pl. 144, fig. 1-4, 1877.
- Pilsbry, Man. Conch., Ser. 2, Vol. VI., p. 187, pl. XI., figs. 41-43, Dec. 16, 1890.

1894—Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 89, June. (synonymised *H. elachystoma* Martens).

As the localities are adjacent, the descriptions and measurements agree there can be no hesitation in accepting Smith's valuation. The size, 19 mm. in breadth by 12 mm. in height, with the perforation concealed, apparently completely, though this is not certain, the coloration and form will make this species easily recognisable when topotypes are secured.

***Rhagada radleyi* Preston 1908.**

Plate IV., fig. 8.

1908—*Rhagada radleyi* Preston, Proc. Malac. Soc. (Lond.), Vol. VIII., p. 120, text. fig., July 20. Western Australia.

Preston described this, without definite locality, as follows: "Shell discoidal, depressed, white, painted above the periphery with two greyish-brown bands, and below with five bands of the same colour; whorls  $4\frac{1}{2}$ , transversely marked with lines of growth, the last whorl descending; sutures well impressed; aperture rather oblique, roundly lunate; peristome expanded, scarcely reflexed; columella descending obliquely, expanded over and almost concealing the umbilicus and diffused above into a slight parietal callus. Alt. 8.5; diam. maj. 15 mm.; aperture, alt. 6; diam. 4 mm. Allied to *R. reinga*, grey, but smaller, and much more depressed; the umbilicus also is not quite closed, as is invariably the case in that species." It is unfortunate that neither the source nor the collector was given, as from the latter we might have traced the exact locality whence this species came. It was not collected by Froggatt, as it does not coincide with any of his shells.

***Rhagada construa* sp. nov.**

Plate IV., fig. 3.

This was recorded by Aneey as *R. reinga*, but it differs from that species in its larger size, different shape and coloration. Shell globose-depressed, shining, banded, sculptured with faint growth lines only, whorls rounded, sutures depressed, columella thickened, appressed, completely sealing nubilical cavity. Coloration white, variously banded, but always with a well-marked brown peripheral band; sometimes one weaker above and three paler below; in rare cases four above and six below of varying strength, rarely are the minor ones completely absent. The long series available shows variation in size and elevation, the type measuring 16 mm. in breadth and 12 mm. in height; the largest measures 19 mm. by 12 mm., and the least 13 mm. by 9 mm., a flattened form being 16 mm. by 10 mm. The immature shell is subkeeled showing a narrow perspective perforation.

Collected by W. W. Froggatt in the Oscar Range, North-West Australia, "among the limestone."

***Rhagada gatta* sp. nov.**

Plate IV., fig. 5.

This was recorded as *Helix reinga* by Smith, who had only one specimen which he noted was "rather flatter and somewhat more finely sculptured" than specimens from other localities. This is very like *construa*, but is larger, broader, and less conoidal. The bands are just as variable, the



broad medium brown band being omnipresent, but all the others are inconstant, from one to three above, and one to six below of different strength. The columella completely seals the umbilicus in the adult. The type measures 18 mm. in height, and 12.5 mm. in breadth.

This was collected by Dr. H. Basedow about the middle of Napier Range, while W. W. Froggatt had previously collected it towards the south end of the same range.

***Rhagada mimika* sp. nov.**

Plate IV., fig. 4.

This is almost a miniature of *gatta* rather than of *construa*, but constantly shows more banding, having usually two bands above the median broad band, and five below, all being fairly strongly coloured brown. The shell has the umbilicus completely sealed, and the type measures 12.5 mm. in breadth with 9 mm. in height, and was collected by W. W. Froggatt in the Napier Range "on grass, etc." These are always small, and the columellar tooth is more marked than in the larger shells.

***Rhagada basedowana* sp. nov.**

Plate IV., fig. 6.

A large series, collected by Dr. H. Basedow "on trees and on *Triodia tussocks*" off the Limestone Caves at the north end of the Napier Range, is uniformly chalky white, the characteristic median band being missing. Some of the juveniles are faintly banded but the coloration soon disappears. As some hundreds were collected this is a striking feature, the shells being solid with the umbilicus completely sealed, but the immature deep narrow perforation persists until the shell is practically full grown, these juveniles being notably keeled, and the last whorl is almost subcarinate. The type measures 15 mm. in breadth and 10 mm. in height, the series varying from 13 to 15 mm. in breadth and 9 to 11 mm. in height.

***Rhagada sutra* sp. nov.**

Plate IV., fig. 9.

This differs from the preceding four species in coloration, but notably in that the umbilicus is never completely sealed up. The shell is small, similarly formed to the preceding forms, but the coloration has massed so that the general appearance of the shell is brownish with a few whitish bands. A few adult shells and many immature ones were "found under logs and damp stones" by W. W. Froggatt in the Napier Range. The type measures 12 mm. in breadth by 8 mm. in height.

***Rhagada convicta* Cox 1870.**

Plate IV., figs. 10-13.

1870—*Helix convicta* Cox, Proc. Zool. Soc. (Lond.), 1870, p. 171, pl. XVI, f. 6, Nov. 11. Nichol Bay, West Australia.

Fig'd. Pilsbry, Man. Conch. (Tryon), Ser. 2 (pt. 23). Vol. VI., p. 187, pl. 14, f. 65 (copy of Cox's figure); pl. 35, figs. 8, 9, 10, Dec. 16, 1890.

1877—*He'ix convicta* Martens, Monatsb. Ak. Wissen. Berlin, 1877, p. 272, pl. I., figs. 6, 7, May No. Mermaid Strait, North-West Australia (T. Studer).

Fig'd. Pilsbry, Man. Conch. (Tryon), Ser. 2 (pt. 23), Vol. VI., p. 187, pl. 30, figs. 7, 11, Copies of Marten's figs. Dec. 16, 1890.

The type and a series of paratypes are bright shining white with a subsutural and a peripheral narrow band of golden brown of medium elevation, subglobose, spire whorls slightly rounded, sutures lightly impressed, last whorl well rounded, base convex, outer lip thick, reflected, columella short, reflected, sealing the umbilicus. Apex apparently smooth but showing fine radial growth lines, the adult sculpture consisting only of similar growth lines with a very fine concentric lining. The type measures 25 mm. in breadth by 18 mm. in height, and for this solid form of Rhagadoid shell a new subgenus, **Tumegada**, is proposed, *convicta* Cox being the orthotype.

The paratypes show comparatively little variation save in the number of the coloured bands, some having two or three above the periphery and six or seven thin ones below the periphery. Many odd shells from the general locality differ in detail but the reason for the differences cannot be ascertained without exact locality. However, one specimen from the Strelley River, collected by Dr. J. R. Cleland, is smaller with less elevation, measuring 20 mm. in breadth by 14 mm. in height, and may represent a new subspecies **R. c. strella** nov.

A couple from Tambrey Station, Fortescue River, are as large as the preceding but flatter, duller in coloration and measuring 20 mm. in breadth by 13.5 mm. in height and these may be subspecifically named **R. c. tambda** nov.

A series collected on Rosemary I. (so named by Dampier) shows a brownish-white shell with three or four pale brown bands, the specimens are smaller than the typical form but comparatively more elevated, the type measuring 18 mm. in breadth by 14 mm. in height, and is regarded as a subspecies **R. c. perprima** nov.

#### **Rhagada tescorum** Benson 1853.

Plate IV., fig. 14.

1853—*Helix tescorum* Benson, Ann. Mag. Nat. Hist., Ser. 2, Vol. XI., p. 30, Jan. 1. Shark's Bay, West Australia.

Fig'd. Reeve, Conch. Icon., Vol. VII., pl. 171, sp. 1154, Oct. 1853. Cox, Mon. Austr. Land Shells, p. 63, pl. IX., fig. 5, May 1868.

1890—*Helix tescorum* Pilsbry Man. Conch. (Tryon), Ser. II., Vol. VI., p. 187, Dec. 16, for Tryon, Vol. IV., p. 256, pl. 36, f. 34, Jan. 3 1889.

1894—*Helix tescorum* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 89, June.

Smith noted: "In form and size this species is very like *H. convicta*; it is, however, remarkable for the cuniculate (sic) suture" adding "It is within the range of possibility that this feature is due to weathering. If, in reality, such be the case, this species should undoubtedly be united with *H. convicta*."

Benson remarked, "the single specimen . . . is apparently in a sub-fossil state."

#### **Rhagada oscarensis** Cox 1892.

Plate IV., figs. 15-16.

1892—*Helix* (*Hadra*) *oscarensis* Cox, Proc. Linn. Soc. N.S.W., Ser. 2, Vol. VI., p. 565, pl. XX., figs. 6-7, May 23. Oscar Ranges, 20 miles from Derby, North-West Australia (W. W. Froggatt).

1894—*Helix* (*Rhagada*) *inconvieta* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 90, pl. VII. f. 10. Junc. Oscar Ranges, 120 miles S.E. of King Sound, North-West Australia.

Shell rather depressed, spire small, last whorl keeled at the periphery, umbilicus not sealed. Apparently this species is restricted to the Oscar Ranges, but there appears to be local variation as in addition to a series of fifteen "under stones" agreeing with the type, and obviously paratypes and topotypes, there is another series of twenty-five "crawling about on the ground" which consists of uniformly smaller shells. Their elevation varies a little, sometimes even more depressed than the larger species, at others comparatively more elevated. These show more colouring, being generally horn with slightly darker flaming above, a broad brown band below the periphery, which fades basally into almost white. The shell is thinner, the lip a little more expanded, and the umbilicus is a little more open. Measurements, breadth 17-18 mm., height 11-12 mm. These may be called *R.o. perca* subsp. nov., the typical shell measuring 18 mm. in breadth by 11 mm. in height.

*Rhagada astuta* sp. nov.

Plate IV., fig. 17.

Among the shells collected at Koolan Island, Yampi Sound, was one more flattened, and upon closer examination it was seen to be sculptured on the upper surface.

Shell flattened, subdiscoidal, spire little elevated, whorls rounded, mouth oblique, wide, open, but lips not flaring, the columella reflected almost closing umbilicus, which is, however, still left open; almost a subnode seen basally on inner edge of lip. The apex worn, but apparently finely striate, striae being seen at suture, the adult whorls sculptured by oblique radials above, the under surface smooth; the radials are very numerous, regular, and distinct. Breadth 20 mm., height 12 mm.

This species is nearest *oscarensis* in form and character, but is even flatter and is easily distinguished by the upper sculpture. This feature is so alien to the true *Rhagada* that this species may prove very distinct, and in order to keep this point in view a new subgeneric name, *Thetagada*, with this as type, is introduced.

Genus **PARRHAGADA** Iredale 1938.

1938—*Parrhagada* Iredale, Austr. Zool. Vol. IX., p. 114, Nov. 30. Orthotype *Thersites woodwardi* Fulton.

This group comprises solid shells with short spire, broad body whorl and the mouth open, the outer lip expanded as a flange giving them a very distinct appearance. The type has the umbilicus tightly sealed, but some of the species, though agreeing very closely in every other feature, leave the umbilicus slightly open.

A very curious ecological note states that one of the most solid was collected "on trees off the Limestone Caves." The solidity of the tree-dweller can only be explained by the abundance of lime in their environment.

*Parrhagada woodwardi* Fulton 1902.

Plate IV., fig. 18.

1902—*Thersites* (*Rhagada*) *woodwardi* Fulton, Proc. Malac. Soc., (Lond.), Vol. V., p. 33, fig. in text, April. North-West Australia.

This species was described by Fulton from specimens sent him by B. R. Woodward, without definite locality. Two specimens in the Perth Museum

are labelled "types," and these are certainly very distinctive in appearance. having a short spire, the umbilicus sealed, but with the mouth open, the lips expanded in a manner quite unlike that of the species *convicta* and *inconvieta*, with which it has been confounded.

The spire is subconical, a little elevated, the periphery subkeeled in the earlier whorls, the last whorl well rounded, the mouth a little descending, the outer lip expanded all round giving it a flaring appearance; the columella reflected, flattened, entirely closing the umbilicus, which is very narrow and open in the young. The shell is chalky white, somewhat bright, not dead, and there is no sculpture save faint growth lines. The type measured 22 mm. in breadth and 15 mm. in height.

Many shells from "On trees off the Limestone Caves," north end of the Napier Range, collected by Dr. H. Basedow.

***Parrhagada sedula* sp. nov.**

Plate IV., fig. 20.

A single specimen collected by Dr. H. Basedow "in rocks" at Limestone Caves, North end Napier Range, differs in size and coloration from those collected on trees somewhere in the same locality. Shell small, whorls rounded, sutures deep, spire a little elate, coloration brownish cream fading on the last whorl, mouth open, lip thin reflected all round, umbilicus sealed. The sculpture is of the same kind, but appears to be a little coarser than in the larger shells, while the apical whorls are smooth and shining, a minute radial striation being only obscurely seen under a strong lens. Breadth 17 mm.; height 11 mm.

***Parrhagada detecta* sp. nov.**

Plate IV., fig. 22.

A fine series, collected by Dr. Herbert Basedow in the Barker River Gorge, Mid Napier Range, differs from another long series secured by the same collector "on trees off the Limestone Caves" at the northern end of the Napier Range, in their smaller size but more in their shape. The whorls are more flattened, the sutures less impressed, the spire more depressed and rounded, the last whorl showing a little subkeeling, and the mouth not so thrown out, more in line with the spire, the outer lip however flaring as in *woodwardi*, and the umbilicus sealed. The type is a dead shell measuring 20 mm. in breadth by 14 mm. in height.

***Parrhagada commoda* sp. nov.**

Plate IV., fig. 19.

Another lot of shells, collected by Dr. H. Basedow and labelled Barker River Gorge, are all dead, and divisible into two series, obviously collected at two different places in the Gorge. One series consists of large shells all weathered white, varying from 20 to 23 mm. in breadth and from 14 to 16 mm. in height. In form, height, appearance these agree very closely with *woodwardi*, but differ in the fact that the columella instead of being appressed, sealing the umbilicus, runs into the cavity and covers half the umbilical opening but leaves it quite unsealed. So many shells have been collected that this character is of valid specific worth in this case, though often such is not the case, and each instance must be judged separately.

**Parrhagada ferrosa** sp. nov.

Plate IV., fig. 21.

This name is given to the smaller shells from the same lot as the preceding as they measure 18 mm. in breadth and 11 mm. in height and are all reddish as if dug out of red earth. These generally agree well with the preceding save in size, and the outer lip is still more expanded and thickened.

In my South Australian essay I pointed out that the variation seen in many cases was difficult to determine. In this case the present "species" may prove to be amply distinct living under different conditions, or it may be an ecological variety only. It may even be a borecol, a name selected to designate a time variety, that is, the shells here treated may be true dwarfs, brought about by climatic conditions of some previous season. It may be a geodecol, that is, a shell living under different ground conditions, the vegetation being unsatisfactory for rapid and full growth, but these items can only be solved by local workers studying these animals under natural conditions.

**Parrhagada koolanensis** sp. nov.

Plate V., fig. 1.

These shells collected on Koolan Island, Yampi Sound, resemble very closely *P. commoda* but with the spire a little more elevated and the mouth not so much thrown out.

Shell subconical, spire elevated, sides rather straight, whorls little rounded, sutures lightly impressed, last whorl subkeeled, mouth descending, open, subcircular, outer lip broadly expanded all round, columella reflected into umbilical cavity not completely closing it, though obscuring it so that only a wide chink is left apparent. Dead shells chalky white, but there are remnants of a thin yellowish periostracum. There is no sculpture save delicate growth striae, the apex smooth. Breadth 22 mm.: height 19 mm.

In this *Parrhagada commoda* complex, this appears to be a real geographical variant in contradistinction to the forms from the Napier Ranges just preceding.

Genus **AMPLIRHAGADA** Iredale 1933.1933—*Amplirhagada* Iredale, Rec. Austr. Mus., Vol. XIX., p. 52, Aug. 2.Orthotype *Helix sykesi* Smith.

This group, which I introduced as a subgenus only, appears to be of higher value and has a distinct range.

Shell stout, spire elevated, whorls rounded, mouth rather small, columella with basal tooth, umbilicus more or less covered. While the species are apparently Rhagadoid the elevation of the spire separates them and it may be that they are less closely related than would appear at first sight. The complexity of the group necessitates subdivision, as in the past through lack of close examination the confusion reached a stage almost defying simplification.

**Amplirhagada sykesi** Smith 1894.

Plate V., fig. 3.

1894—*Helix (Hadra) sykesi* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 92, pl. VII., fig. 8, June. Parry Island, Admiralty Gulf, N.W. Australia.

A paratype is here figured and described. Shell fairly large, conical, spire well elevated, whorls rounded, sutures deeply impressed, last whorl descending, well rounded though earlier a little keeled, mouth oblique, open,

outer lip thickened and reflected, columella very slanting, bearing a small prominent tubercle anteriorly, reflected over and closing the umbilicus save for a minute chink. Coloration shining with a subsutural and a peripheral narrow band of golden brown. Apex very finely striate, adult sculpture of fine regular radial striae, a subordinate fine concentric lining developing later which almost overcomes the radials on the body whorl. There is a strong creamy callus connecting the columella with the outer lip across the body whorl. Breadth 22 mm., height 18 mm.

***Amplirhagada montalivetensis* Smith 1894.**

Plate V., fig. 5.

1894—*Helix (Hadra) montalivetensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 91, pl. VII., fig. 21, June. Montalivet I., North-West Australia.

Smith described *sykesi* by comparison with *montalivetensis*, so the process may here be reversed, a paratype again being used. Shell much more depressed than the preceding though the coloration is the same, the mouth is more open, the tubercle on the columella is broader and more flattened, the columella more expanded, but the umbilicus is left more open though obscured. The outer lip seems more expanded with an antelabial ditch present, and the base appears flattened around the umbilicus. Breadth 21.5 mm., height 15 mm.

***Amplirhagada herbertena* sp. nov.**

Plate V., fig. 6.

A specimen collected by Dr. H. Basedow in the Buccaneer Archipelago, the exact island not indicated, was regarded by Hedley as representing "*montalivetensis* Smith var.," but it is quite distinct.

Shell fairly large for this group, subconical, spire elevated, base flattened appreciably, the last whorl subkeeled, the whorls fine with two apical whorls which are apparently smooth. The whorls are convex with sutures scarcely impressed producing a characteristic appearance. The sculpture is of faint growth radials, but on the last whorl, with a strong lens, a light subordinate fine concentric striation can be discerned. Mouth well open, outer lip thin, a little reflected, basally thickening and producing a flattened tubercle, columella curved, thickened, reflected, half covering the open narrow perspective umbilicus. Base a little convex, then flattened and surrounding the umbilical cavity with a subdued ridge. Breadth 22 mm., height 17 mm.

***Amplirhagada imitata* Smith 1894.**

Plate V., fig. 7.

1894—*Helix (Hadra) imitata* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 92, pl. VII., fig. 15, June. Bandin, N. Maret, and Condillae Islands and Cape Bougainville, N.W. Australia.

This was distinguished on account of its coarse sculpture above, and this feature immediately separates it. I select Bandin I. as the restricted type locality and figure a specimen from that locality. Shell medium, elevated, whorls rounded, strongly obliquely striate above, the striations becoming lirae almost, disappearing, however, on the base. A little more elevated than *montalivetensis* and a little less than *sykesi*, it shows the apertural and columellar features of the latter almost exactly. There is, however, no coloration seen, and the breadth is 20 mm., with a height of 15 mm.

Specimens from Vansittart Bay, N.W. Australia, collected by Capt. W. Burrows, are more elevated and have finer sculpture above, although this is still strong and well marked. One specimen shows a peripheral and sub-sutural brown band. Height 16 mm.; breadth 20 mm. This specimen is named **A. burrowsena**. (Plate V., fig. 9.)

**Amplirhagada combeana** Iredale 1938.

Plate V., fig. 10.

1938—*Amplirhagada combeana* Iredale, Austr. Zool, Vol. IX., p. 113, Nov. 30, new name for.

1894—*Helix (Hadra) imitata* var. *cassiniensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 92, pl. VII., fig. 16, June. Cassini Islands, North-West Australia.

Not *H. millepunctata* var. *cassiniensis* Smith, op. cit. p. 88.

This is a delightful little species judging from a paratype which is here figured.

Shell smaller than preceding, more solid, comparatively more elevated, mouth more thickened, rather smaller, sculpture coarser and more prominent on base, whorls more rounded, sutures deeper. There is also a golden peripheral narrow band, but no sub-sutural colour can be seen.

Breadth 15.5 mm.; height 12.5 mm.

**Amplirhagada burneriensis** Smith 1894.

Plate V., fig. 11.

1894—*Helix (Hadra) burneriensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 91, pl. VII., fig. 18, June. Burner (error pro Barrier) Ranges, Derby District, N.W. Australia (Cox).

This species appears to fall into *Amplirhagada* though it is outside the range of the other *Amplirhagada*. It is quite unlike its associates geographically and I note that Smith allied it to *sylvesi*.

A series of sixty labelled by Froggatt "among the limestones" shows a peculiar coloration, the upper whorls greyish white probably through the dead animal, as some are horn or creamy, the last two whorls creamy suffused below the suture and towards the umbilicus with rich amber. The apex is radially granulose, the usual fine growth radial sculpture with a very fine concentric lining present, on the adult whorls. These are rounded, last whorl large, mouth a little descending, outer lip thin, slightly reflected, columella straight, short, reflected sealing the umbilicus. Breadth 21.5, height 15 mm.

A smaller horny shell, associated with the preceding, is more conical, thinner, last whorl subkeeled, mouth more open, apex less granulose, adult sculpture a little coarser. Its exact status is at present unknown, it may be a *horeocol*, but for the present it is named **A. terma** sp. nov. the type measuring 15.5 mm. in breadth by 11.5 mm. in height. (Plate V., fig. 8.)

**Amplirhagada novelta** sp. nov.

Plate V., fig. 12.

Shell subglobose, spire conical, rather elevated, whorls rounded, last whorl large, descending at mouth which is large, open, subcircular, outer lip thin, slightly expanded, columella small but reflected, sealing the umbilicus.

The dead shell is whitish with a faint brownish peripheral narrow band. The apex is almost smooth, but shows slight radial striae, the adult sculpture is faint radial growth lines, somewhat irregular in strength. Breadth 23 mm.; height 17.5 mm.

Compared with *sykesi*, this species has a much more conical spire, more flattened whorls and lacks the columellar tubercle while the umbilicus is completely sealed, there is not the slightest chink showing.

Collected on the Drysdale River, Napier Broome Bay, North-West Australia.

Genus **TENUIGADA** gen. nov.

Type **T. percita** sp. nov.

Many thin shells are labelled "In rocks, Limestone Caves, Napier Range," and these do not correlate with any of the named groups. Shell thin, helicoid, a little conical, umbilicate, whorls rounded, sutures shallow, last whorl rather bulky, mouth descending, a little oblique, subcircular, the outer lip thin, reflected, the columella slanting, broadly reflected across and hiding the umbilicus but not appressed.

These shells have a different texture from the preceding Rhagadoid forms while the columella does not enter the umbilical cavity nor is it appressed but expands across the umbilical opening. The apex is finely radially striate, whereas generally in Rhagadoid shells the apical whorls are smooth.

**Tenuigada percita** sp. nov.

Plate V., fig. 14.

Shell thin, transparent, subglobose, spire somewhat elate, conical, whorls rounded, sutures little impressed, last whorl with a faint peripheral keel at beginning, periphery well rounded finally, outer lip a little descending, mouth roundish, open, outer lip thin, reflected all round, the columella broadly angulately reflected over umbilicus which however is not closed by it. The apex is rather coarsely radiate, the radials breaking up into granules, the succeeding sculpture being rather coarse growth radials, almost radial riblets, which become weaker with age when concentric striation appears, and this can also be seen obscurely on the base. A callus connects the outer lip and the columella. Coloration pale brownish horn. Breadth 19 mm.; height 14 mm.

Collected in rocks at the Limestone Caves, North End of Napier Range, by Dr. H. Basedow.

**Tenuigada ignara** sp. nov.

Plate V., fig. 13.

Collected with the preceding, but probably in a slightly different location, were many smaller specimens of the same type, but there were paler in coloration, more depressed, the peripheral keel more noticeable, smaller, the mouth more descending, the umbilicus comparatively larger and more open. The apex is more strongly granulose, the adult radial sculpture weaker, the concentric striae scarcely discernible. Breadth 16 mm.; height 10.5 mm.

Genus **EXILIGADA** gen. nov.

Type **Exiligada negriensis** sp. nov.

Mr. Richard Helms, in the year 1896, collected a number of shells at Negri Outstation, twenty-five miles north of Ord River Station, East Kimberley. Two species were procured and they do not fall into any Rhagadoid



group previously known, and are quite unlike any other type of Australian land mollusc.

The shell is depressed, spire little elevated, whorls a little rounded, last whorl rounded, base somewhat flattened, umbilicate, mouth fairly large, outer lip a little recurved.

The notable features are the texture and coloration. The shell is strong, but not as stout as true *Rhagada*, and the shells are banded profusely but not in the *Rhagadoid* style. In the type the bands are broken into bars by growth periods, but in the second species the bands are continuous, twelve to sixteen bands being counted on the last whorl. The columella is reflected, leaving the umbilicus exposed in the type but almost concealing it in the second species.

***Exiligada negriensis* sp. nov.**

Plate V., fig. 4.

Shell subdiscoidal, large, spire a little elevated, whorls little rounded, last whorl however well rounded at the periphery, mouth descending a little, aperture oblique, subcircular, open, outer lip reflected a little all round, flattened basally, columella slanting, broadly reflected but not obscuring the umbilicus, which is narrow but open, shell rather solid.

Coloration peculiar: whitish encircled by a number of brown lines interrupted by growth stages so that the lines appear as a series of dashes, the lines are practically of the same width and number about a dozen on the last whorl, three above the peripheral one which is no stronger than the others, the remainder on the base. The apex is quite smooth, and apparently stopped by a varix, the adult whorls being only sculptured by very faint growth striae only. The base is somewhat flattened, the umbilical area excavate.

Breadth 22 mm.; height 11 mm.

***Exiligada qualis* sp. nov.**

Plate V., fig. 2.

Shell with the spire more elevated than in the preceding species, the whorls a little rounded, the sutures impressed, the mouth large, the outer lip a little recurved but not flattened basally. The shell has the same texture as the preceding and is surely related, but at first sight it differs as the coloured bands are unbroken. The ground colour is whitish and the lines are more numerous, two about the periphery being much broader than the remainder and a brighter red-brown. There are half a dozen above and half a dozen below with even one narrow line between the two broad ones.

The apex is apparently smooth but there are microscopic radial striations present, the adult shell being very finely radially growth striate throughout.

The columella is a little arcuate and expanded, closing the umbilicus save for a chink.

Breadth 20 mm.; height 14 mm.

Genus **PLECTORHAGADA** Iredale 1933.

1933—*Plectorhagada* Iredale, Rec. Austr. Mus., Vol. XIX., p. 52, Aug. 2.  
Orthotype *Helix plectilis* Benson.

This group has a different facies from *Rhagada*, the spire being more conical, the mouth descending more rapidly and being more circular, the umbilicus being open though hidden by the expansion of the columella, and

the characteristic sculpture. The apex is smooth, the adult whorls rugosely plicate, the pliae irregular, and overall a curious granulation. This sculpture is so peculiar that the type species appears to have been described three times. Reeve calling the sculpture "crumpled," which is probably the best word used.

**Plectorhagada plectilis** Benson 1853.

Plate V., fig. 15.

1853—*Helix plectilis* Benson, Ann. Mag. Nat. Hist., Ser. 2, Vol. XI., p. 29, Jan. 1. Shark Bay, West Australia.

Fig'd. Reeve, Conch. Icon., Vol. VII., pl. 172, sp. 1162, Oct., 1853.

Cox, Mon. Austr. Land Shells, p. 44, pl. IX., fig. 17 (copy of Reeve's figure); pl. XX., fig. 8, from a painting of the type by Angas, May, 1868. Tryon, Man. Conch., Ser. II., Vol. III., p. 215, pl. 49, fig. 18, 1887. Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. VI., p. 88, pl. 35, figs. 16, 17, 18, 1890.

1854—*Helix paleata* Reeve, Conch. Icon., Vol. VII., pl. 199, sp. 1399, Dec. Banks of the Swan River, Australia (Bacon).

Tryon, Man. Conch., Ser. II., Vol. III., p. 215, pl. 49, fig. 17, 1887. (Cox and Pilsbry, *op. cit.*, treat this as a synonym of above.)

1864—*Helix carcharias* Pfeiffer, Proc. Zool. Soc. (Lond.), 1863, p. 528, Apl. 20, 1864. Shark Bay, West Australia.

Fig'd. Cox, Mon. Austr. Land Shells, p. 45, pl. XX., fig. 12 (from a painting of the type by Angas), May, 1868.

The locality "Banks of the Swan River" is definitely incorrect, the species being only known from Shark Bay. Some are labelled Dirk Hartog's Island and it is possible that there may be races or even distinct species on the islands such as Dirk Hartog, Bernier, Dorre, as well as Peron Peninsula. Péron recorded that helicoid land-shells were abundant on those islands, and we have no series for examination yet. The specimen labelled "Dirk Hartog's Island" is undoubtedly the same as those labelled "Shark Bay," and probably all are from the one lot. This measures 15.5 mm. in breadth by 11 mm. in height, and agrees very closely with Angas' painting of the type of *plectilis*. Pfeiffer's *carcharias*, according to Angas' painting, is more conoidal, and is a living specimen, "flesh-coloured," all the dead shells being white.

Rensch (Zool. Jahrbuch (Syst.), Jena, Bd. 63, heft 1, pp. 1-130, Apl. 12, 1932), dealing with the Molluscan Fauna of the Sunda Expedition, has recorded (p. 94). *Rhagada plectilis supracostulata* Schepman, from Sumba, recording as additional races of *R. plectilis*, *plicata* Preston, *colona* Martens, and *saracensis* Schepman. Such reviews by continental workers, being based on scant material and no local knowledge, are very misleading. The Australian shells, thus associated by Rensch as "races," *plectilis* and *plicata*, have little close relationship, and are very definitely not conspecific. The mere fact that they come from Western Australia seems to be the decisive factor in Rensch's judgment.

**Plectorhagada rovinia** sp. nov.

Plate V., fig. 17.

A very beautiful little shell from Shark Bay, regarded as the missing *H. australis* Menke, is here described, as it is quite unlike the description of the Menkean species. Shell small, stout, subglobose with elevated spire, sutures deep, whorls very rounded, mouth large and circular, umbilicus

narrow, open, columellar reflection slight, outer lip thin not reflected, coloration shining white, with two faint brown bands on last whorl, one peripheral, the other midway between this and suture. Apical whorls, one and a half, smooth, adult whorls five and one half, sculptured with close wavy irregular rough ridges, subgranulose, base a little smoother. Columella a little curved with a strong glaze connecting inner and outer lip, but not forming a continuous aperture.

Height, 11 mm.; breadth, 12 mm.; aperture, 6 mm. high by 6 mm. broad.

While the rough sculpture is not identical with that of *plectilis*, it recalls that, and no other Western Australian shell has any sculpture at all like. This species is therefore placed tentatively under *Plectorhagada*, but as its shape is so different from that of the type, a new subgeneric name is here introduced, *Idamera*, with *P. roxina* as type.

Genus **BELLRHAGADA** Iredale 1938.

1938—*Bellrhagada* Iredale, Austr. Zool., Vol. IX., p. 114, Nov. 30. Orthotype *Rhagada plicata* Preston.

Smallest Rhagadoid shells, flattened globose, imperforate, sutures almost canalliculate, mouth subcircular, lip little expanded, sculpture of regular radials weaker on the base, the apical whorls large and smooth.

This little shell is quite similar to the type of *Rhagada* but is plicate above, and is here differentiated, as it appears to have an extra-Australian representative in *supracostulata*, which has the umbilicus not completely sealed.

**Bellrhagada plicata** Preston 1914.

Plate V., fig. 16.

1914—*Rhagada plicata* Preston, Proc. Malac. Soc. (Lond.), Vol. XI., p. 13, fig. in text, Mch. 30. Montebello Is., West Australia.

The smallest of the Rhagadoid series, this shell is flattened globose, spire short, very little elevated, whorls little rounded, sutures deep, last whorl descending a little, mouth subcircular, open, outer lip a little reflected, basally thickened; columella slanting, appressed, sealing the umbilicus save for a minute chink, coloration white with one broad peripheral band, two narrower above, and half a dozen below: these are pale brown but may be darker in life.

The sculpture is peculiar, the apical whorls smooth, the adult whorls with flattened oblique distinct radials, these persisting obscurely on the base. Breadth 10 mm.; height 8 mm.

[**Helix dringi** Pfeiffer 1846.

1846—*Helix dringi* Pfeiffer, Symb. Helic., Vol. III., p. 73, "Austral. oriental. (Dring in Mus. Cuming)."

1848—*Helix dringi* Pfeiffer, Mon. Helic. viv., Vol. I., p. 289, "Australia oriental, prope 'Torres Strait' (Dring)."

1852—*Helix dringi* Reeve, Conch. Icon., Vol. VII., pl. 128, sp. 769, October.

1868—*Helix dringi* Cox, Mou. Austr. Land Shells, p. 64, pl. XI., fig. 9, May.

1890—*Helix dringi* Pilsbry, Man. Conch. (Tryon), Ser. II., Vol. VI., p. 186, Dec. 16, fig. for Vol. IV., pl. 36, fig. 40, Jan. 3, 1889, where there is no text.

All these references refer to the single specimen collected by Dring, and credited to Eastern Australia, near Torres Strait. The figure recalls species

of *Torresitrachia*, but these are always openly umbilicated, while this is described as having a covered umbilicus, which suggests *Rhagadoid* affinity. Drug collected on the West Coast so that it is possible that this species was found somewhere on the west, rather than on the East Coast.]

Genus **GLOBORHAGADA** Iredale 1933.

1933—*Globorhagada* Iredale, Rec. Austr. Mus., Vol. XIX, p. 52, Aug. 2.

Orthotype *Helix* (*Hadra*) *prudhoensis* Smith.

I distinguished this form as a subgenus of *Rhagada*, observing that the type species was globose, with open circular mouth, the columella thickened, much reflected and appressed, but not closing the umbilicus, a thick glaze joining the inner and outer lips.

The globose form separates this group clearly and the apertural characters appear distinct from those of true *Rhagada*. The columella crosses the umbilical cavity whereas the *Rhagada* species have it entering it.

**Globorhagada prudhoensis** Smith 1894.

Plate V., fig. 19.

1894—*Helix* (*Hadra*) *prudhoensis* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 91, pl. VII., fig. 9. Prudhoe Island, N.W. Australia (Lieut. J. W. Combe, H.M.S. "Penguin").

"Shell umbilicate, globose (whitish, clothed with a yellowish epidermis); whorls five convex, rapidly increasing, striate with oblique growth lines, the last whorl large, inflated, obliquely descending suddenly at the aperture; spire obtusely conoidal; aperture rotundately-lunate, length about three-fifths of the height of the shell; peristome interiorly slightly thickened, outwardly scarcely expanded, a little effuse anteriorly, a thin callus joining the margins, columella oblique, reflected, dilated above, almost hiding the umbilicus. Diam. mag. 25, min. 20 mm.; alt. 22 mm. Aperture 14 long, 11.5 broad. Hab. as above.

This is a smooth globular species, probably without much coloration, judging from the only two specimens at hand. These are in a dead condition, without any trace of colour, and probably are more or less bleached. The umbilicus is deep and moderately broad; the inner edge of the oblique columella is gently arcuate, but the outer margin is almost straight or faintly incurved."

**Globorhagada leptogramma** Pfeiffer 1846.

Plate V., fig. 18.

1846—*Helix leptogramma* Pfeiffer, Proc. Zool. Soc. (Lond.), 1845, p. 127, Feb. 1846. Cygnet Bay, North Australia (Ince).

Fig'd. Reeve, Conch. Icon., Vol. VII., pl. LXXXII., sp. 437, Mch. 1852. Cox, Mon. Austr. Land Shells, p. 41, pl. XI., fig. 4, May 1868. Smith, Zool. Erebus & Terror, Moll., p. 2, pl. IV., fig. 18, 1874. Tryon Man. Conch., Ser. 2, Vol. IV., p. 256, pl. 36, fig. 33, 1887.

Specimens from Broome agree fairly save that they are slightly larger, and topotypical examples are not available.

Shell globose, spire very short, last whorl very large and bulky, whorls rounded, sutures deep, last whorl descending a little, mouth almost circular wide open, outer lip a little reflected all round, columella very slanting across

the umbilical cavity concealing the umbilicus but not closing it, a thick glaze crosses the body whorl from columella to outer lip. Dead shell white with four brownish bands on body whorl, two narrow above the periphery, one a little broader peripheral and another similar just below. Sculpture of growth striae only.

Height 19 mm.; breadth 21 mm.

***Globorhagada montebelloensis* Preston 1914.**

Plate V., fig. 20.

1914—*Rhagada montebelloensis* Preston, Proc. Malac. Soc. (Lond.), Vol. XI., p. 13, fig. in text, Melb. 30. Montebello Is., West Australia.

Shell subglobose, spire short, whorls well rounded, mouth round wide, columella thick reflected, almost closing umbilicus. This is a flatter shell than *leptogramma*, more depressed, somewhat recalling some forms of *Rhagada* but with the columellar features of *Globorhagada*.

Shell brownish white with one peripheral pale brown band. Apex finely radially striate, adult sculpture only of rough radial growth striae, smoother on base.

Height 13 mm.; breadth 17 mm.

***Globorhagada obliquirugosa* Smith 1894.**

Plate V., fig. 21.

1894—*Helix (Hadra) obliquirugosa* Smith, Proc. Malac. Soc. (Lond.), Vol. I., p. 90, pl. VII., fig. 17, June. Parry Harbour, North-West Australia.

The original description reads: "Shell globose, narrowly perforate, white, clothed with a thin yellowish epidermis, striate with oblique growth lines, everywhere obliquely irregularly corrugated; whorls five convex, rapidly increasing, sutures deeply impressed, last whorl large, globose, slightly descending at the aperture; aperture oblique, broadly imate, white; spire moderately elevated, somewhat obtuse at the apex; peristome slightly thickened, scarcely expanded above, a little reflected below, the columellar margin dilated broadly, especially at the insertion, thus partly concealing the umbilicus. Diameter major 21, min. 16.5 mm; height 18 mm. Aperture 14 long, 10 broad. Only dead specimens of this species were obtained, almost entirely denuded of the periostracum. The remains of it, however, within the aperture show that it was of a yellowish tint. One example, fresher than the rest, has the spire of a very pale brownish tint, so it is likely that this species, when living, is of a light brownish colour above, and covered with a thin periostracum."

**FAMILY OCCIRHENEIDAE.**

For the present it is better to use a name such as the above to include a species from Western Australia whose status is unknown. I introduced the generic name *Occirhenea* for *Helix georgiana* Quoy and Gaimard, which had been placed previously under *Rhytida*, *Flammulina* and *Zonites*, none of which occurs in this area.

Genus **OCCIRHENEAE** Iredale 1933.

1933 *Occirhenea* Iredale, Rec. Austr. Mus., Vol. XIX., p. 48, Ang. 2. Orthotype *Helix georgiana* Quoy and Gaimard.

I wrote, "The strongly sculptured base, narrow umbilicus, and produced outer lip differentiate" this species which had previously been placed under *Rhytida*, *Flammulina* and *Zonites*, three genera representing distinct groups of superfamily distinction. Apparently although the figure shows a strongly sculptured base this is an error in the drawing.

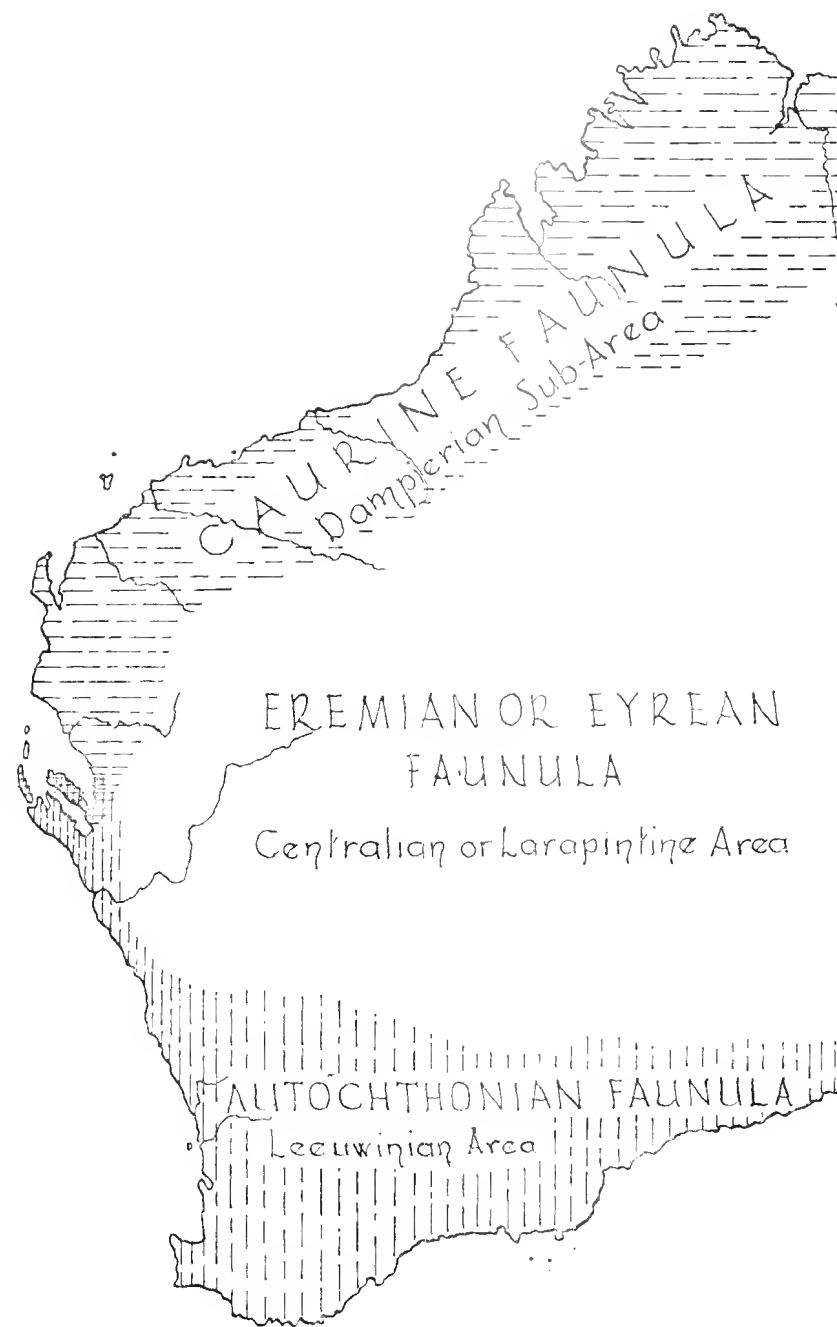
**Occirhenea georgiana** Quoy and Gaimard 1832.

Plate V., figs. 22 and 22a.

1832—*Helix georgiana* Quoy and Gaimard, Voy. Astrol. Zool., Vol. II., p. 129, pl. X., figs. 26-30. King George Sound, South-West Australia.

Shell orbicular, transloid and fragile, strongly striated above, yellow; whorls four, the last cylindraceous; aperture large, subrotund; lip thin. Diameter 5 lines, height 2 lines.

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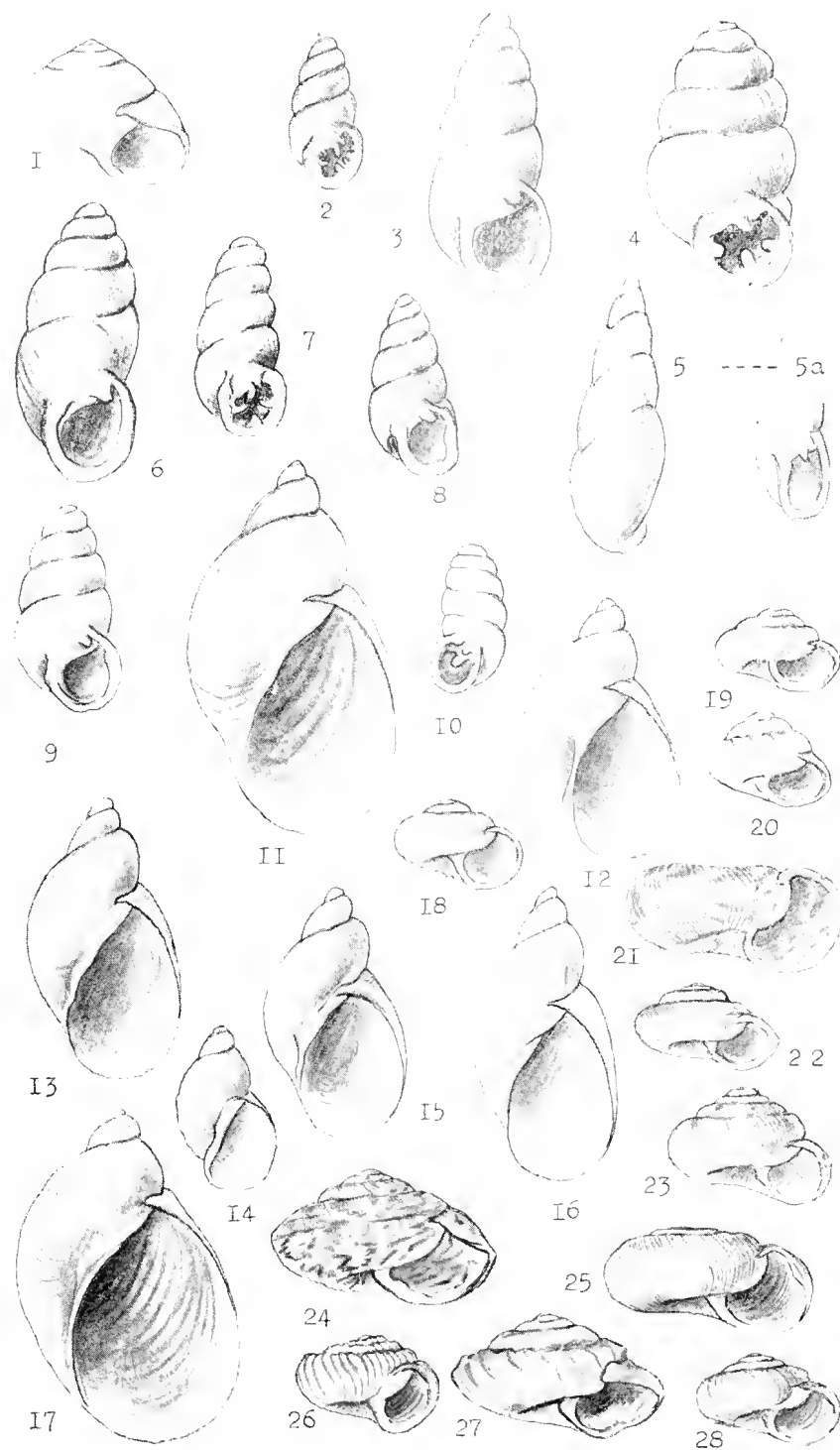
WESTERN AUSTRALIA.





## EXPLANATION OF PLATE I.

- Fig. 1. *Pleuropoma walkeri* Smith.  
 2. *Australbinula helmsiana* Iredale.  
 3. *Themapupa belliana asserta* Iredale.  
 4. *Australbinula mooreana* Smith.  
 5, 5a. *Themapupa lepidula* A. Adams and Angus.  
 6. *Themapupa belliana contracta* Iredale.  
 7. *Australbinula complexa* Iredale.  
 8. *Themapupa dirupta* Iredale.  
 9. *Themapupa anapocifica* Iredale.  
 10. *Omegapilla occidentalis* Iredale.  
 11. *Anstrosuccinea scalarina* Pfeiffer.  
 12. *Anstrosuccinea contenta* Iredale.  
 13. *Anstrosuccinea contenta isolata* Iredale.  
 14. *Arborecinea monkiana* Pfeiffer.  
 15. *Anstrosuccinea aridicola* Iredale.  
 16. *Anstrosuccinea caurina* Iredale.  
 17. *Anstrosuccinea cori* Finlay.  
 18, 28. *Westralaoma carperla* Iredale.  
 19. *Westralaoma scitula* Iredale.  
 20. *Gratilaoma cara* Iredale.  
 21. *Luinodiscus repens* Iredale.  
 22. *Insullaoma predicta* Iredale.  
 23. *Pernagera albanensis* Cox.  
 24, 27. *Annoscheila dolosa* Iredale.  
 25. *Luinodiscus cygneus* Benson.  
 26. *Epiniacum restifer* Iredale.

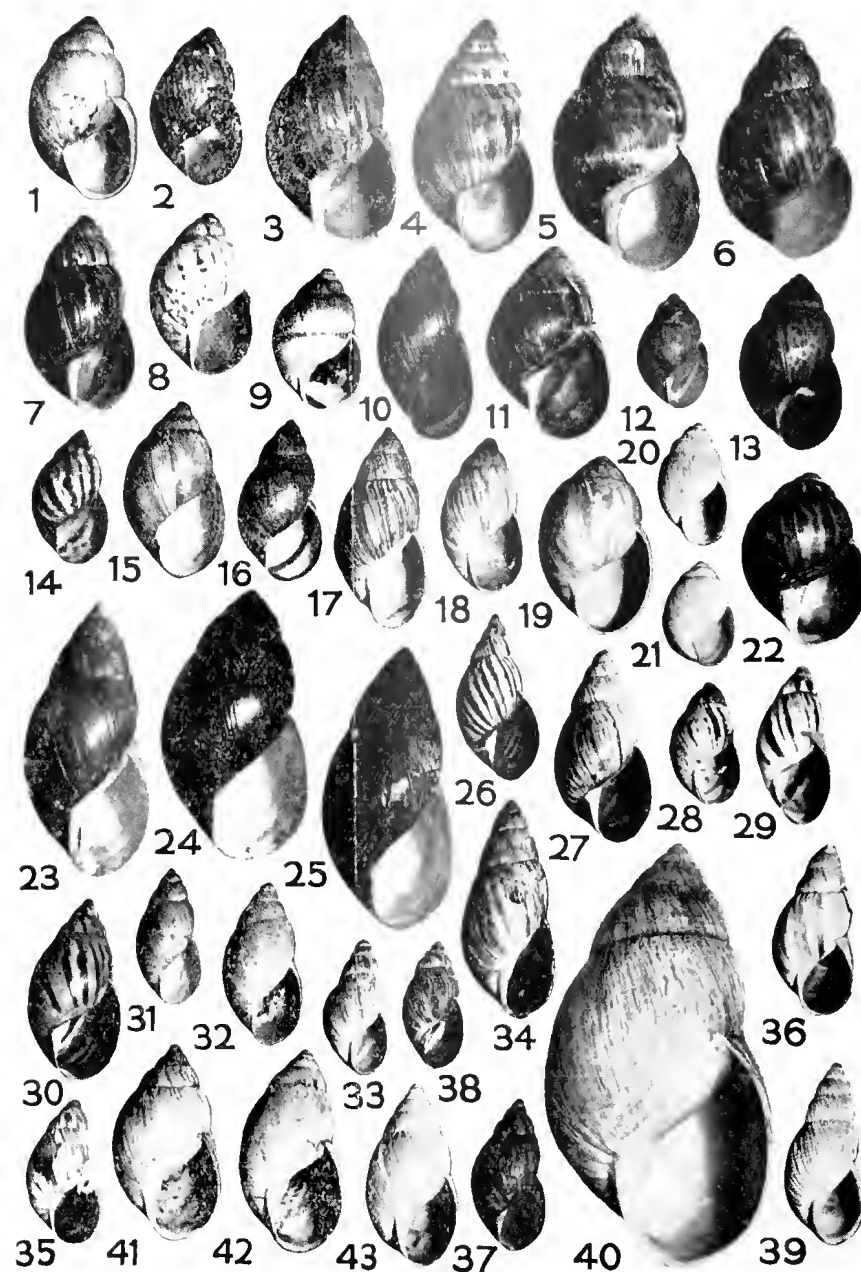




## EXPLANATION OF PLATE II.

Fig. 1. *Bothriembryon melo* Quoy and Gaimard.

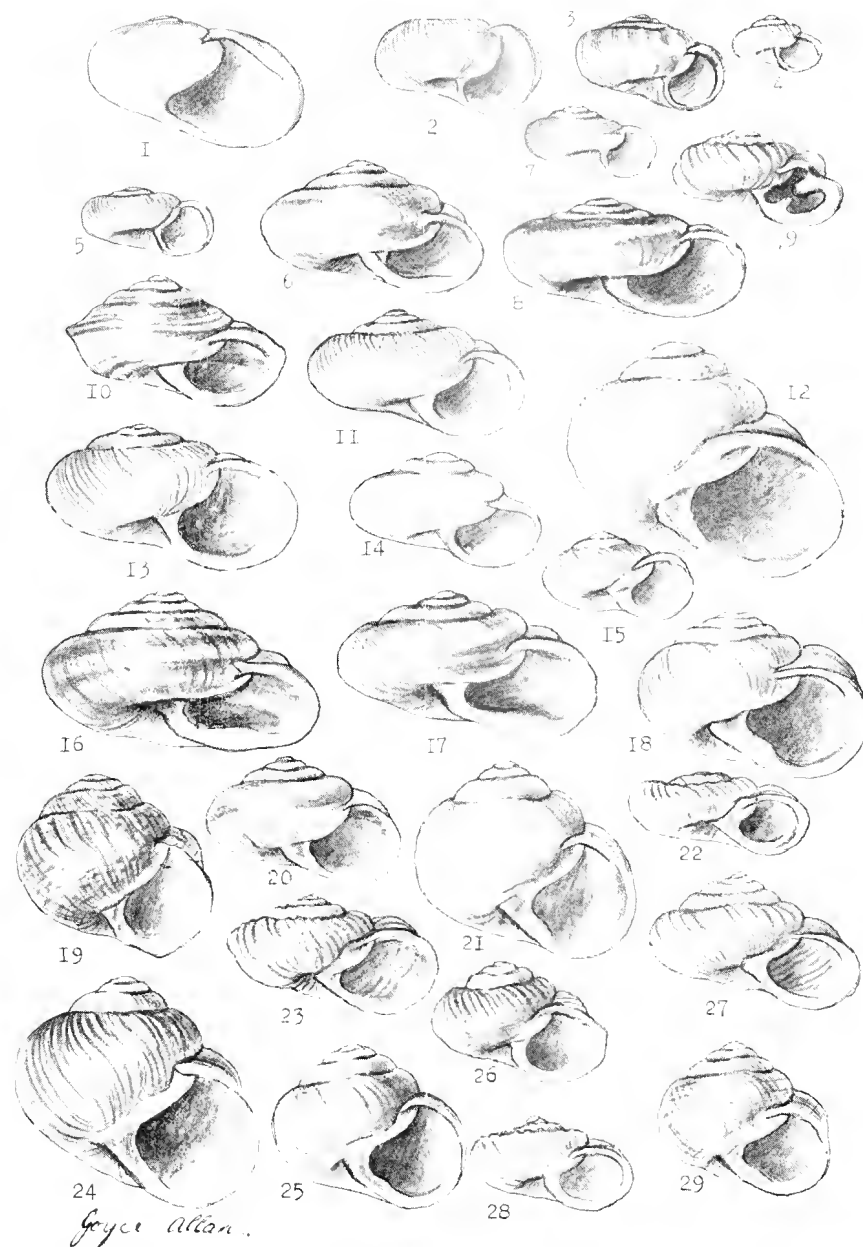
2. " *castaneus* Pilsbry.  
 3. " *rhodostomus* Gray.  
 4. " " *hullianus* Iredale.  
 5. " " *grantiannus* Iredale.  
 6. " " *wrightiannus* Iredale.  
 7. " " *perspectus* Iredale.  
 8. " *esperantia* Iredale.  
 9. " *balteolus* Iredale.  
 10. " *serpentinus* Iredale.  
 11. " *praececlus* Iredale.  
 12. " *sedgwicki* Iredale.  
 13. " *bulla* Menke.  
 14. " *bradshawi* Iredale.  
 15. " *irvineanus* Iredale.  
 16. " *richeanus* Iredale.  
 17. " *leewardsensis* Smith.  
 18. " " *eventus* Iredale.  
 19. " *costulatus* Lamarck.  
 20. " *minor* Pilsbry.  
 21. " *whitleyi* Iredale.  
 22. " *perobesus* Iredale.  
 23. " *indutus* Menke.  
 24. " *glanerti* Iredale.  
 25. " *franki* Iredale.  
 26. " *kingii* Gray.  
 27. " " (*trilineatus*).  
 28. " " (*humilis*).  
 29. " *notatus* Iredale.  
 30. " *jacksoni* Iredale.  
 31. " *mairelli* Kobelt.  
 32. " *perditus* Iredale.  
 33. " *sayi* Pfeiffer.  
 34. " " (*solidus*).  
 35. " *naturalistarum* Kobelt.  
 36. " " (large form).  
 37. " *resectus* Iredale.  
 38. " *brazieri* Angas.  
 39. " *gratwicki* Cox.  
 40. " *dux* Pfeiffer.  
 41. " *barrettii* Iredale.  
 42. " " *indictus* Iredale.  
 43. " *distinctus* Iredale.





## EXPLANATION OF PLATE III.

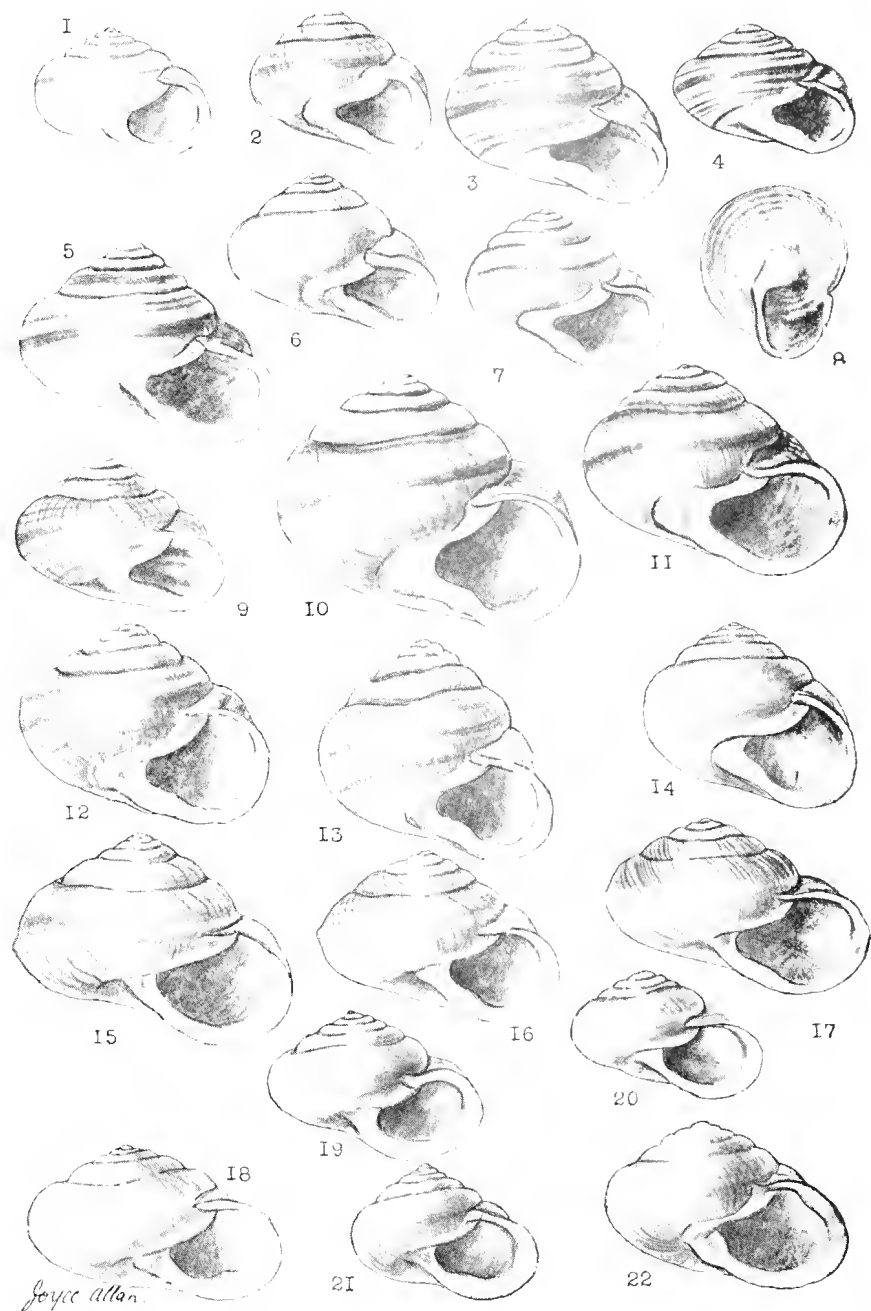
- Fig. 1. *Lunation castaneus* Pfeiffer.  
 „ 2. *Lunodiscus tumidus* Odhner.  
 „ 3. *Pernagera lena* Iredale.  
 „ 4. *Westralatoma expicta* Iredale.  
 „ 5. *Lunodiscus cupreus* Cox.  
 „ 6. *Westraltrachia derbyi* Cox.  
 „ 7. *Westralatoma apica* Iredale.  
 „ 8. *Westraltrachia orthocenta* Aneey.  
 „ 9. *Baudinella baudinensis* Smith.  
 „ 10. *Westraltrachia froggatti* Aneey.  
 „ 11. *Torresitrachia bathurstensis* Smith.  
 „ 12. *Kimboraga micromphala* Gude.  
 „ 13. *Torresitrachia monticola* Iredale.  
 „ 14. *Westracystis tentus* Iredale.  
 „ 15. *Pleuroxia polypleura elina* Iredale.  
 „ 16. *Westraltrachia incerta* Iredale.  
 „ 17. *Westraltrachia alterna* Iredale.  
 „ 18. *Sinumelon datum* Iredale.  
 „ 19. *Sinumelon nullarboricum* Tate.  
 „ 20. *Quistrachia monogramma* Aneey.  
 „ 21. *Sinumelon lennum* Iredale.  
 „ 22. *Pleuroxia abstant* Iredale.  
 „ 23. *Pleuroxia oligopleura namba* Iredale.  
 „ 24. *Sinumelon vagante* Iredale.  
 „ 25. *Sinumelon kalgun* Iredale.  
 „ 26. *Pleuroxia commenta* Iredale.  
 „ 27. *Pleuroxia polypleura* Tate.  
 „ 28. *Pleuroxia oligopleura* Tate.  
 „ 29. *Sinumelon lennum mutuum* Iredale.





## EXPLANATION OF PLATE IV.

- Fig. 1. *Rhagada torulus* Ferussac.  
 „ 2. „ *reinga* Gray.  
 „ 3. „ *construa* Iredale.  
 „ 4. „ *mimika* Iredale.  
 „ 5. „ *gatta* Iredale.  
 „ 6. „ *basedowana* Iredale.  
 „ 7. „ *richardsonii* Smith.  
 „ 8. „ *radleyi* Preston.  
 „ 9. „ *sutra* Iredale.  
 „ 10. „ *convicta* Cox.  
 „ 11. „ „ *strella* Iredale.  
 „ 12. „ „ *lambra* Iredale.  
 „ 13. „ „ *perprima* Iredale.  
 „ 14. „ *tescorum* Benson.  
 „ 15. „ *oscarensis* Cox.  
 „ 16. „ „ *perea* Iredale.  
 „ 17. „ *astuta* Iredale.  
 „ 18. *Parrhagada woodwardi* Fulton.  
 „ 19. „ *commoda* Iredale.  
 „ 20. „ *sedula* Iredale.  
 „ 21. „ *ferrosa* Iredale.  
 „ 22. „ *detecta* Iredale.

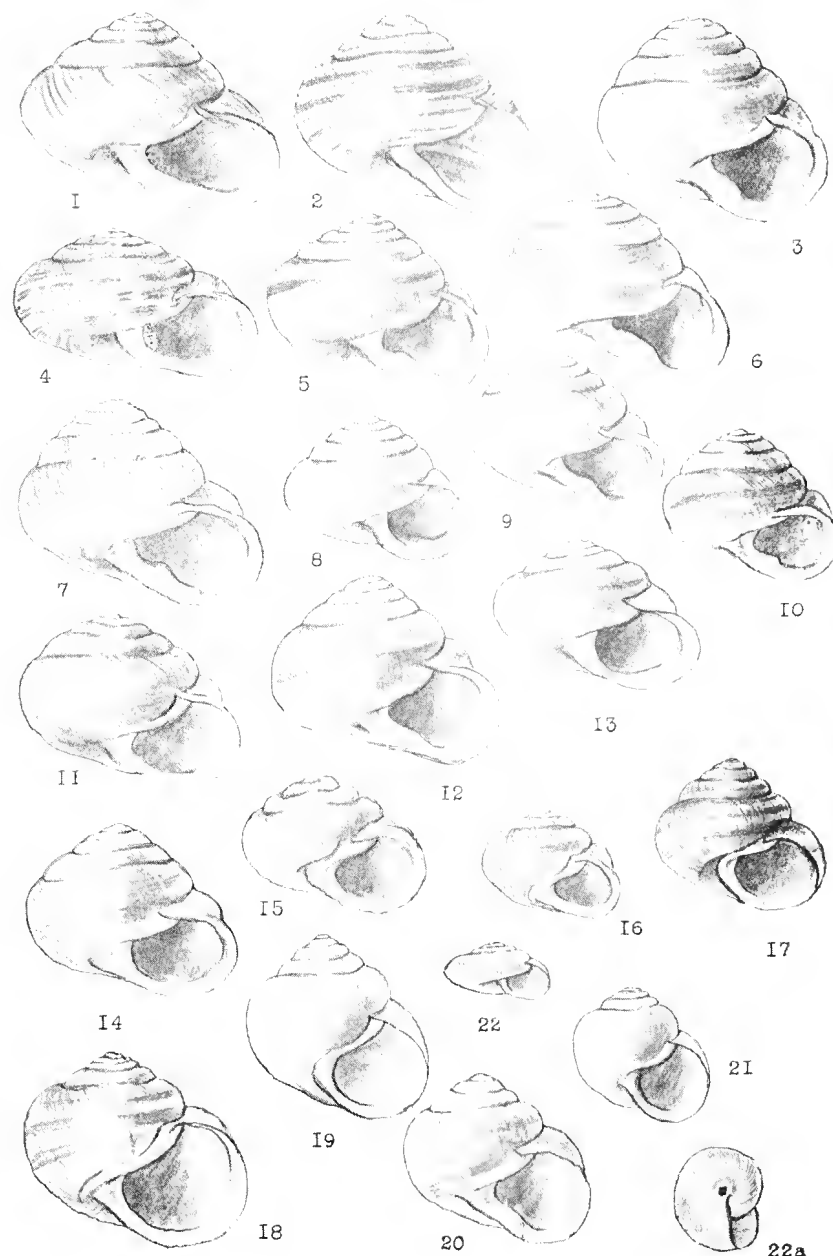






## EXPLANATION OF PLATE V.

- Fig. 1. *Parrhagada koolanensis* Iredale.  
 „ 2. *Exiligada qualis* Iredale.  
 „ 3. *Amplirhagada sylvis* Smith.  
 „ 4. *Exiligada negriensis* Iredale.  
 „ 5. *Amplirhagada montalirensis* Smith.  
 „ 6. „ *hebertiana* Iredale.  
 „ 7. „ *imitata* Smith.  
 „ 8. „ *terma* Iredale.  
 „ 9. „ *burrowsiana* Iredale.  
 „ 10. „ *combcana* Iredale.  
 „ 11. „ *burnensis* Smith.  
 „ 12. „ *novella* Iredale.  
 „ 13. *Tenuigada ignara* Iredale.  
 „ 14. „ *perita* Iredale.  
 „ 15. *Plectorhagada plicilis* Benson.  
 „ 16. *Bellrhagada plicata* Preston.  
 „ 17. *Plectorhagada rorina* Iredale.  
 „ 18. *Glotrhagada leptogramma* Pfeiffer.  
 „ 19. „ *pruthocensis* Smith.  
 „ 20. „ *montebelloensis* Preston.  
 „ 21. „ *obliquirugosa* Smith.  
 „ 22. & 22a. *Occirhena georgiana* Quoy & Gaimard.



Joyce Allan



## INDEX.

	Page		Page
albansis .....	56	elachystoma .....	59
albanensis .....	40	elina .....	55
alterna .....	51	Ephialtes .....	43
amphibia .....	15	esperantia .....	21
Amphibagada .....	65	eventus .....	25
anapacifica .....	10	Exiligrada .....	68
angasiana .....	53	Eximiorbagada .....	57
Angasella .....	54	experta .....	37
Angasietta .....	55	expicta .....	37
Annoselix .....	39		
aperta .....	14	Ferrosa .....	65
aprica .....	38	firmatum .....	43
Arborella .....	15	fodinalis .....	54
aribinda .....	14	forrestiana .....	47
aspermum .....	57	franki .....	29
asserta .....	11	froggatti .....	50
astuta .....	63	fusens .....	29
Australbunda .....	7		
australis .....	52	Gantonina .....	55
Austrosarinea .....	12	gascoyensis .....	56
		gatta .....	60
baconi .....	23	georgiana .....	74
balteolus .....	21	ghuerri .....	20
barretti .....	35	Globorbagada .....	72
basedowiana .....	61	Glyptorbagada .....	57
basedowi .....	57	godfreyi .....	58
batlarstenensis .....	48	Gumbandina .....	49
Bandinella .....	40	gratiana .....	21
bandinensis .....	5, 49	Gratibunda .....	38
Bellragada .....	71	gratwicki .....	34
belltrana .....	11		
Bothriembryon .....	17	Hartogenbryon .....	17
brad-shawi .....	24	hartogensis .....	27
brazieri .....	34	hedleyi .....	41
brevissima .....	15	Helicaria .....	45
bullinus .....	30	Helicina .....	5
bulla .....	23	heinsiana .....	8
burnerensis .....	67	herbertiana .....	66
burrowsiana .....	67	hullianus .....	20
cara .....	38	humilis .....	30
carcharias .....	70		
cassidensis .....	16, 67	Hamera .....	71
castaneus .....	19, 45	ignara .....	68
caurina .....	13	imitata .....	66
Celatembrion .....	36	inconvicta .....	63
Cerinasola .....	14	increti .....	51
Chloritis .....	46	indictus .....	36
collingii .....	49	indutus .....	28
conclena .....	67	inlatus .....	26
conclenata .....	55	Insullama .....	38
conclunda .....	64	invincens .....	24
complexa .....	7	isolata .....	13
conspira .....	23		
construa .....	60	jacksoni .....	31
contenta .....	13		
confecta .....	11	Kalgum .....	53
contraria .....	9	Kimbaraga .....	47
convicta .....	61	kingii .....	29
Corinoma .....	43	Koolamensis .....	65
costulatus .....	26		
coxi .....	14	Larapintembryon .....	17
cuprens .....	40	leewardsensis .....	25
Cyclophorus .....	6	lena .....	40
cyzicus .....	41	lenum .....	54
cyrtopleura .....	55	lepidula .....	10
		leptozanma .....	72
Damochlora .....	46	linebichensis .....	12
datum .....	53	Liparis .....	17
derbyana .....	50	liricinctum .....	6
derbyi .....	50	lisus .....	44
deserti .....	8	lunariu .....	45
defecta .....	64	Lunodiscus .....	40
Dialembryon .....	16		
dirupta .....	10	mauliferus .....	19
distinctus .....	36	martensi .....	20
diolosa .....	30	maxwelli .....	31
dringi .....	71	nelo .....	17
Duponcharopa .....	43	neukena .....	15
durns .....	23	micromphala .....	47
dux .....	35	millemelata .....	46

## INDEX—continued.

nillestriata .....	43	qualis .....	69
nimika .....	61	Quistrachia .....	51
nivor .....	27	quoyi .....	30
monogramma .....	52		
montalivetensis .....	66	radiata .....	57
montehelloensis .....	73	radleyi .....	60
monticola .....	48	rectilabrum .....	47
mooreana .....	8	reinga .....	59
morti .....	37	repens .....	42
mutumu .....	54	restifer .....	43
		revestus .....	33
naturalistarum .....	33	Rhagada .....	58
negriensis .....	69	rhodostomus .....	19
notatus .....	31	richardsonii .....	59
Notobadistes .....	52	richeanus .....	24
noventa .....	67	riddlei .....	38
nullarboricum .....	53	rovina .....	70
numba .....	56		
nupera .....	41	Satagembryon .....	17
		sayi .....	32
obliquitugosa .....	73	scalarina .....	13
oblouga .....	13	scitula .....	37
occidentalis .....	12	sedgwicki .....	22
Oecirhenea .....	74	sedula .....	64
oligopleura .....	56	serpentinus .....	22
Omegapilla .....	12	Setobandinia .....	49
onslovi .....	26	sinistralis .....	9
orbiculatum .....	6	Sinuacelon .....	52
orthocella .....	51	solidus .....	33
oscarensis .....	62	strella .....	62
ovum .....	18	strigillata .....	14
		subgramosa .....	48
		sublestus .....	41
		sutra .....	61
		sykesi .....	65
pacifica .....	10	tambra .....	62
paleata .....	70	Telembryon .....	16
pallidus .....	35	tentus .....	44
Paralaoma .....	37	Tenuigada .....	68
Paralogenia .....	47	terna .....	67
Parrhagada .....	63	tescorum .....	62
pelodes .....	47	Themapupa .....	9
perca .....	63	Thetagada .....	63
percita .....	68	thomsoni .....	45
perditus .....	32	Torresitrachia .....	48
perinflata .....	54	torulus .....	58
Pernagera .....	40	Trachia .....	50
perobesus .....	28	trilineatus .....	30
Perochlora .....	46	Tumegada .....	62
perprina .....	62	tundus .....	42
perspectus .....	21		
physalis .....	18	vagente .....	54
physodes .....	18		
plectilis .....	70	wallabyensis .....	7
Plectorhagada .....	69	walkeri .....	5
Pleuropoma .....	5	westracystis .....	44
Pleuroxia .....	54	westralaoma .....	36
plicata .....	71	westraltrachia .....	50
polyploera .....	55	whitleyi .....	27
Ponembryon .....	16	woodwardi .....	63
ponsonbii .....	28	wrigdianus .....	21
praecepsus .....	22		
predicta .....	38		
prudhoeensis .....	72		
primum .....	48		
psendoprimum .....	47		
		Zygotrachia .....	50













